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Directional Stability and Time History Response Analysis of a General Truck Combination

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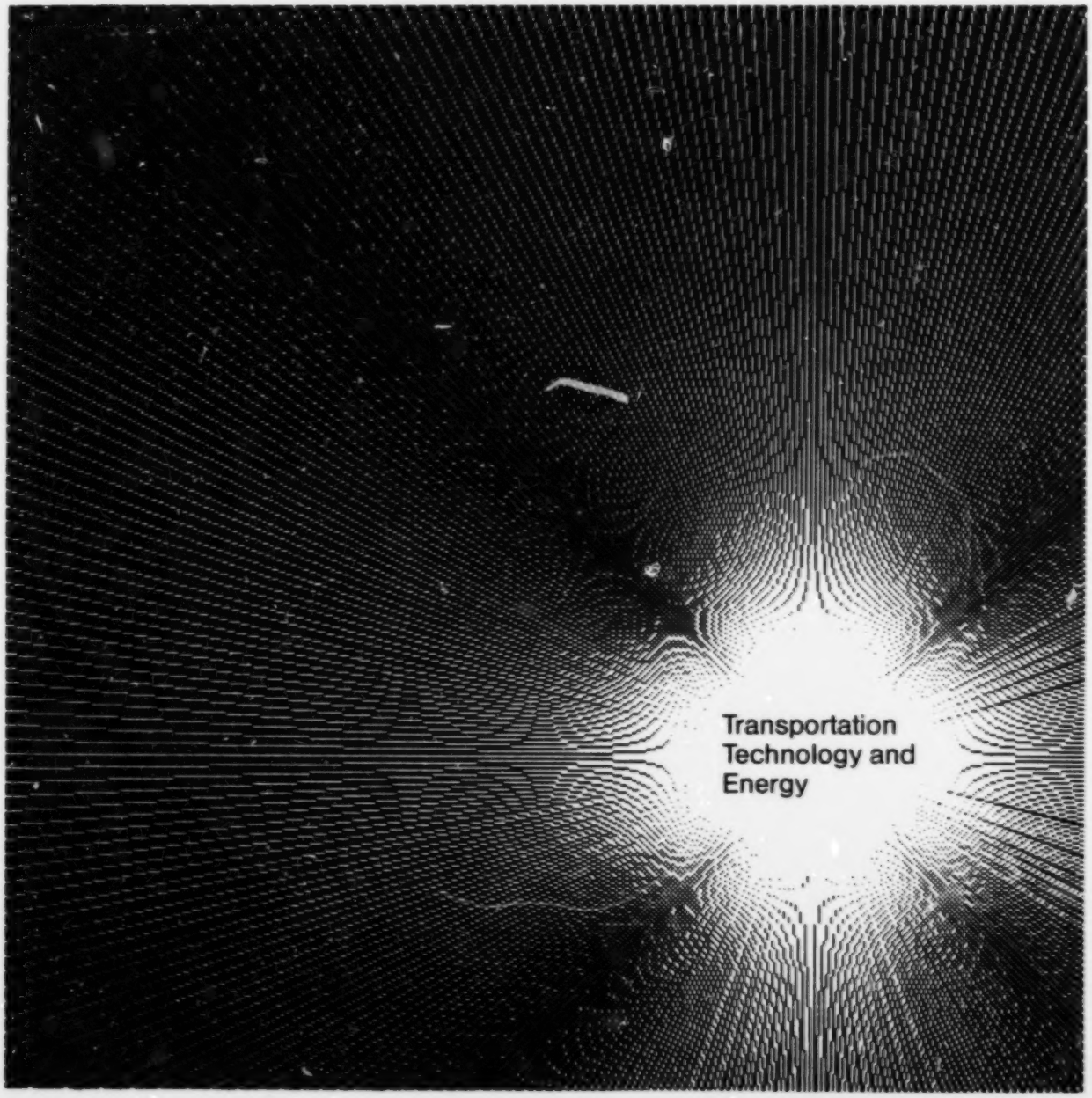

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Directional Stability and Time History Response Analysis of a General Truck Combination

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Transportation Technology Office

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ABSTRACT

A linearized digital computer model has been developed for a general truck combination of arbitrary length which interfaces with the MTC in-house general purpose dynamic analysis package DYNSYS. The model can be used to study the directional response and stability of heavy commercial vehicles in a horizontal plane. In a preliminary study, the simplicity of the model allows it to be used effectively to identify vehicle combinations for further detailed analysis or field test. The solution capabilities of DYNSYS permit either a stability analysis, a frequency response analysis, or a time history response analysis of the linear equations representing the vehicle.

Key Words: General truck combination, dynamic analysis, stability analysis, time history response, eigenvalue, eigenvectors, parametric studies

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ABSTRACT

A linearized digital computer model has been developed for a general truck combination of arbitrary length which interfaces with the MTC in-house general purpose dynamic analysis package DYNSYS. The model can be used to study the directional response and stability of heavy commercial vehicles in a horizontal plane. In a preliminary study, the simplicity of the model allows it to be used effectively to identify vehicle combinations for further detailed analysis or field test. The solution capabilities of DYNSYS permit either a stability analysis, a frequency response analysis, or a time history response analysis of the linear equations representing the vehicle.

Nomenclature

C - sum of the cornering stiffnesses of the tire at the tire-road interface for each axle (N/r)

CS - sum of longitudinal stiffnesses of the tire at the tire-road interface for each axle (N)

D - viscous damping at the hitch location (N-s/m)

F - lateral force at each axle (N)

I - yaw moment of inertia of a vehicle unit ($N\text{-}m^2$)

i - subscript for vehicle unit

j - subscript for axle unit

K - rotational stiffness at the hitch location (N-m/r)

m - mass of a vehicle unit (kg)

M - sum of the aligning moments at each axle (N-m)

N - sum of aligning moment/unit slip angle of all tires mounted on an axle (N-m/r)

r - yaw rate of a vehicle unit (r/s)

SX - distance between the hitch location and the centre of gravity of a vehicle unit (m)

U - forward velocity at the centre of mass of a vehicle unit (m/s)

V - lateral velocity at the mass centre of a vehicle unit (m/s)

X - distance between an axle and the mass centre of the vehicle unit where the axle is located (m)

Y - dual tire spacing (m)

Γ - articulation angle between two adjacent truck units (r)

α - sideslip angle of the tire at an axle (r)

δ - steer angle at the front axle (r)

$\dot{\ }$ - derivative of the variable with respect to time

q_i - number of axles on unit i

l_i - number of linkages on unit i

z_i - number of vehicle units in tow with unit i

1/ INTRODUCTION

A number of digital computer models have been developed to study the dynamic response of heavy commercial vehicles. They range from simple models with only a few degrees of freedom, to a highly complex model with up to 71 degrees of freedom [1]. Although these models may differ in analysis and simulation techniques, one thing they share in common is that their programs are only capable of studying a single vehicle combination, or are limited to a few vehicle combinations. As far as vehicle directional stability analysis is concerned, models are available in the literature for study of the stability of commercial vehicles up to a double [2,3].

However, de-regulation of the trucking industry and more liberal weight allowances have resulted in increased productivity through innovative designs, such as vehicles with more than three articulation points, or with self-steering axles [4,5]. The dynamic characteristics of such vehicles can be rather complex. Thus, the need is evident for a model which can be used to study the stability and directional response of a truck combination of any configuration. This report outlines such a linear mathematical model developed at MTC, and describes the data required for running the program.

2/ SCOPE OF THE MODEL

The objective of this analysis is to develop a simple linear mathematical model which can be implemented in a program which interfaces with the MTC dynamic analysis package, DYNSYS [6], for study of the stability and directional response of a general truck combination. The following are the special features and capabilities specified for the model:

1) The vehicle may have any number of vehicle units;
2) There shall be no limit to the number of axles on each unit;
3) The model shall be flexible enough to allow representation of any potential vehicle configuration;
4) The same model shall be used for either stability analysis or time history response analysis;
5) The model shall facilitate parametric studies; and
6) The model shall be simple to use.

3/ ANALYSIS

3.1/ Model Concept

The analysis is based on the model employed in References 2 and 3. However, the model is extended to include an arbitrary number of vehicle units, with an arbitrary number of axles on each unit. Rotational stiffness and linear viscous damping may also be included at the hitch location between a towing unit and a towed unit. The following assumptions are made in this analysis to simplify the mathematics of the model:

1) Two degrees of freedom, namely lateral velocity and yaw rate, are allowed for each unit in the horizontal plane.
2) Cornering force and aligning moment generated at the tire-road interface are linear functions of the sideslip angle of the tire.
3) Articulation angles, γ, are small such that sine and cosine of these angles can be approximated by γ and 1, respectively.
4) The vehicle is moving at a constant forward velocity on a horizontal plane with uniform friction characteristics.
5) Longitudinal tire forces are assumed to be so small that they can be ignored.
6) Pitch and roll motion of the sprung masses are small, and hence are neglected.
7) Gyroscopic effects are ignored.

In order to generate the equations of motion and kinematics of an arbitrary vehicle combination, two basic linking concepts are introduced to generalize the formulation of the vehicle model, "chainage" and "in tow" of a vehicle unit.

"Chainage" (or linkage) of a vehicle unit is defined as the list of vehicle units that are linked in a continuous fashion from the tractor to that vehicle unit. Figure 1 shows an A-train double combination that will be used to illustrate this concept. The numbering system of the units is as shown in Figure 1. With this vehicle, the chainage for Unit 3 is 1, 2, and 3, and the chainage for Unit 4 is 1, 2, 3 and 4. This concept is essential to determine the lateral velocity of vehicle units, as is required later in the equations of motion.

"In tow" of a vehicle unit is defined as the list of vehicle units trailing that vehicle unit. Referring to the vehicle combination in Figure 1, the list of vehicle units "in tow" to Unit 4 is 4, and the list of vehicle units "in tow" to Unit 1 is 1, 2, 3 and 4. The concept of "in tow" is necessary to generalize the formulation of the equations of motion in the vehicle model.

3.2/ Equations of Motion

Based on the above assumptions and definitions, a free body diagram can be formed for each vehicle unit. Figure 2 shows the free body diagram of two adjacent vehicle units. Two equations are available to describe the motion of each unit trailing the tractor, the moment equation and the yaw constraint at the hitch location. The motion of the tractor can be defined by the moment equation and the lateral force equation of the complete truck combination. A total of 2n equations therefore define a truck combination of n units.

The force equation for an entire n unit truck-train combination is given in Equation 1.

$$\sum_{i=1}^{n} m_i \dot{V}_i - \sum_{i=1}^{n} \sum_{j=1}^{q_i} F_{ij} + \sum_{i=1}^{n} m_i U_i \, r_i = 0 \qquad (1)$$

Equation 2 gives the moment equation for unit i. Similar equations can be derived for each vehicle unit.

$$I_i \dot{r}_i = \sum_{k=1}^{l_i} (SX_{ik}(P_k - Q_k)) - \sum_{j=1}^{q_i} (F_{ij} X_{ij} - M_{ij}) + \sum_{k=1}^{l_i} (K_i \Gamma_{ik} + D \dot{\Gamma}_{ik}) \qquad (2)$$

The kinematic constraint equation for each trailing unit is defined by Equation 3.

$$\dot{\Gamma}_{i,i-1} = r_i - r_{i-1} \qquad (3)$$

Supplementary equations for the symbols defined in Equations 1 and 2 are given below.

For $i > 1$,

$$V_i = V_1 - \sum_{t=2}^{i} (SX_{t-1,t}\, r_{t-1} + SX_{t,t-1} r_t) + \sum_{t=1}^{i-1} U_t r_t \tag{4}$$

where t is the unit in front of and in direct chain connection with unit i.

The tire side force is given by:

$$F_{ij} = -C_{ij}\, \alpha_{ij} \tag{5}$$

For non-steering axles, the sideslip angle α is defined by:

$$\alpha_{ij} = (V_i - X_{ij}\, r_i)/U_i \tag{6}$$

For front-steering axle, $\alpha_{11} = (V_1 + X_{11} r_1)/U_1 - \delta$ (7)

The aligning moment at each axle is given by:

$$M_{ij} = N_{ij}\, \alpha_{ij} - CS_{ij}\, Y_{ij}^2\, r_i/U_i \tag{8}$$

Finally, the values of P and Q in Equation 2 are given by:

$$P_i = \sum_{w=1}^{z_i} m_w (\dot{V}_w + U_w r_w) \tag{9}$$

$$Q_i = \sum_{w=1}^{z_i} \sum_{j=1}^{q_i} F_{wj} \tag{10}$$

The set of Equations 1 to 10 can be re-arranged in state-space matrix form as:

$$[A]\{\dot{x}_i\} = [B]\{x_i\} + \{C\} \tag{11}$$

where $[A]$ and $[B]$ are 2n x 2n matrices, $\{C\}$ is a 2n vector, and $\{X_i\}$ are vectors of the 2n state variables.

3.3/ Stability Analysis

For stability analysis, vector $\{C\}$ in Equation 11 is set to zero. Thus Equation 11 becomes:

$$[A]\{\dot{x}_i\} = [B]\{x_i\} \tag{12}$$

Assuming a solution exists for $\{x_i\}$

i.e., $$\{x_i\} = \{\psi\}e^{\lambda t} \tag{13}$$

therefore

$$\{\dot{x}_i\} = \lambda\{\psi\}e^{\lambda t} \tag{14}$$

Substitute Equations 13 and 14 into Equation 12:

$$[A]\lambda\{\psi\}e^{\lambda t} = [B]\{\psi\}e^{\lambda t}$$

$$[A]\lambda\{\psi\}e^{\lambda t} - [B]\{\psi\}e^{\lambda t} = 0$$

$$([A]\lambda - [B])\{\psi\}e^{\lambda t} = 0 \tag{15}$$

Equation 15 has non-trivial solutions if and only if:

$$([A]\lambda - [B])\{\psi\} = 0 \tag{16}$$

This is a generalized eigenvalue problem which, in general, has 2n solutions for pairs of λ, $\{\psi\}$.

The values λ_i are called eigenvalues, and the corresponding values $\{\psi_i\}$ are the eigenvectors. Together they provide a full description of the stability characteristics of the system.

In general, λ_i can either be complex or real. That is,

$$\lambda_i = \alpha_i + i\beta_i$$
$$\bar{\lambda}_i = \alpha_i - i\beta_i \qquad \text{for a complex conjugate.}$$

or $$\lambda_i = \alpha_i$$

If λ_i is complex, the system will possess an oscillatory frequency equal to $\beta_i/2\pi$ Hz and a damping ratio, γ_i, defined by $-\alpha_i/\sqrt{\alpha_i^2 + \beta_i^2}$. The system is said to be stable when γ_i is positive, neutral when γ_i equals zero, or unstable when γ_i is negative.

If λ_i is real, the system is said to have a non-oscillatory mode having a damping ratio of α_i. The system is stable when α_i is negative and unstable when α_i is positive.

The dynamic characteristics of the vehicle can further be understood by the values of $\{\psi_i\}$ which gives the mode shape of the system.

3.4/ Time History Response

Time history response is a more straightforward solution than the stability analysis. A small steer angle is assumed to be input at the front axle, and it and other initial conditions are defined in vector $\{C\}$ of Equation 1. The change in value of the state variables of Equation 1 are computed as a function of time by direct integration. These state variables can then be manipulated to yield the trajectory and any other variables which are useful to describe the motion of the truck combination as a function of time in response to the steer input.

4/ IMPLEMENTATION

The mathematical model is implemented in a program which interfaces with the MTC dynamic analysis package called DYNSYS for analysis solution [6]. DYNSYS is a computer package developed to provide for dynamic analysis of a general mechanical system. It consists, in the present form, of three solution modules, namely, linear stability analysis, time history response and spectral analysis. Figures 3 and 4 show the program structure of the DYNSYS package and the control of flow through the program, respectively [6]. In this analysis, the stability analysis and time history response modules are used. With DYNSYS, the need to completely rewrite a program to solve a particular dynamic problem is eliminated. By specifying the proper solution module and its parameters in the input dataset, the same program with minor modification can be used to solve any of the above dynamic problems. Details of how to use DYNSYS can be found in Reference 6.

The vehicle model is generated into the program by coding user-supplied subroutines within the DYNSYS program structure. Figure 5 shows the flow for user-supplied matrix generation [6].

This vehicle model includes a computation procedure for its overall physical properties with respect to its centre of gravity. This provides flexibility to the user to change payload location and value at will, by invoking this option and supplying the appropriate data. The input requirements for this option are the physical properties of the empty vehicle and the properties of each payload and its corresponding location as shown in Figure 6. The model allows as many payloads as desired, limited only by the dimension defined in the program.

Additional parametric studies are included in the model to take advantage of the looping feature in the DYNSYS package. This is implemented by varying the value of one parameter at each pass of a computer run.

5/ VALIDATION

The complete program for the vehicle model has been checked for code correctness. The special features built into the model have been tested for proper execution. Since DYNSYS has seen extensive use, no validation of its model definition and solution procedures was necessary.

Since there is no publicly available program that can be used to study the stability of a truck combination beyond a double, and an experiment to correlate with this analysis would be extrememly difficult, the program can only be evaluated against the published results of a similar program for vehicles up to a double combination [3]. The results of the stability analysis of a tractor semi-trailer and the time history response of an A-train double obtained from this program were compared with that published in Reference 3. There was no practical difference between the results from both sources, except as would be expected from different code, numeric precision and rounding error. The program in Reference 3 has been shown to give satisfactory results when compared with experimental data. It can therefore be concluded that the program developed at MTC compared favourably with that of Reference 3 and, by induction, the general truck train model should also be valid for vehicles beyond a double combination. It must be cautioned that satisfactory simulation results can only be obtained with accurate input data. Therefore, effort should be made to ensure the input data gives a true representation of the mechanical and physical properties of the vehicle.

6/ INPUT DATA REQUIREMENTS

Basically, there is only one set of data required by the dynamic analysis programs and the input data for the truck combination model is part of this dataset. However, a slightly different dataset is required for each solution module. The entire dataset can be broken down into three individual segments. The first segment defines the solution module and its associated parameters. The second segment provides the input data for the truck combination model, and the third segment defines the parameters for the solution module.

This section will only describe the input requirements for the truck combination model. A complete list of module parameters and solution parameters for the stability analysis and time history response are included in Reference 6.

The units employed in this model are the SI system, with mass in kilogram, force in newtons, length in metres, and time in seconds.

The input formats for the vehicle model is tabulated in Table 1.

Card 1 - defines the number of vehicle units and the total number of equations for the model.

Card 2 - defines the unit number of the vehicle unit whose physical properties are described in the ensuing cards.

Card 3 - is a title card of the vehicle unit.

Card 4 - has three fields. The first field defines the number of vehicle units in tow, including itself. The second field gives the number of vehicle units in chainage, including itself. The third field is the number of hitches on the unit.

Card 5 - gives the list of vehicle units in tow.

Card 6 - gives the list of vehicle units in chainage.

Card 7 - gives the numbers of the vehicle units linked at the hitches defined in the third field of Card 4.

Card 8 - defines the mass of the empty vehicle unit, its yaw moment of inertia, C.G. distance with respect to front tractor axle or kingpin location, number of axles, number of payloads, and indicator for overall C.G. calculation.

Card 9 - defines the hitch location relative to the tractor front axle or the kingpin of the unit.

Card 10 - defines the mass, moment of inertia and centres of gravity of a payload, relative to either tractor front axle or kingpin location, as appropriate, and is repeated to define each payload.

Card 11 - defines the properties of the axle. The first field defines the centre of gravity of the axle with respect to front tractor axle or kingpin. The next four fields define the cornering stiffness, aligning torque, circumferential stiffness and dual tire spacing of the tire, respectively. This card will be repeated for as many axles as defined in Card 8.

Card 12 - defines the rotational stiffness and viscous damping at the vehicle unit hitch location.

Cards 2 to 12 are repeated for each additional vehicle unit of the truck combination.

Table 1/ Input Format for Vehicle Model

CARD	FIELD	FORMAT	VARIABLE	DESCRIPTIONS
1	1	I10	NUNIT	Number of vehicle unit $1 < NUNIT < 6$
	2	I10	NEQT	Number of equations $2 < NEQT < 12$
2	1	I10	IUNO	Unit number
3	1	10A4	TITLE	Unit title card
4	1	I10	NTR	Number of vehicle units in tow $1 < NTR < 6$
	2	I10	NLI	Number of vehicle units in linkage $1 < NLI < 6$
	3	I10	NLA	Number of hitches $1 < NLA < 6$
5	1	I10	NTRAX	Unit number in tow. Will have as many fields as defined in Field 2 of Card 4.
6	1	I10	LINX	Unit number in linkage. Will have as many fields as defined in Field 2 of Card 4.
7	1	I10	LATCX	Vehicle unit number at hitch #1. Will have as many vehicle unit numbers as hitches defined in Card 4.
8	1	F10.4	WMEMTY	Vehicle unit mass
	2	F10.4	WEIMTY	Vehicle unit yaw moment of inertia
	3	F10.4	CGEMTY	Unit C.G. W.R.T. front tractor axle or kingpin location
	4	I10	NAX	Number of axle $0 < NAX < 6$
	5	I10	NPYLD	Number of payloads $0 < NPYLD < 10$
	6	I10	INDIC	Indicator for C.G. calculation YES = 1, NO = 0.
9	1	F10.4	SXREAR	Hitch location W.R.T. tractor front axle or kingpin location. Repeat as many fields as defined in Card 4.
10	1	F10.4	WMPYLD	Mass of payload
	2	F10.4	WIPYLD	Payload moment of inertia
	3	F10.4	CGPYLD	Payload C.G. location W.R.T. front axle or kingpin location
	CARD 10 WILL BE REPEATED FOR EACH ADDITIONAL PAYLOAD			
11	1	F10.4	XAXLE	Axle distance W.R.T. tractor front Axle or kingpin location
	2	F10.4	C	Tire cornering stiffness/axle
	3	F10.4	CN	Tire aligning torque/axle
	4	F10.4	CS	Tire circumferential stiffness/axle
	5	F10.4	Y	Dual tire spacing
	CARD 11 WILL BE REPEATED FOR EACH AXLE			
12	1	F10.4	VIS	Viscous damping coefficient at hitch location
	2	F10.4	SK	Rotational stiffness at hitch location
	CARD 2 TO CARD 12 WILL BE REPEATED FOR EACH VEHICLE UNIT			

7/ PROGRAM OUTPUT

There are two types of output from the program. The first type is simply an echo of the input data set, and a listing with descriptions as interpreted by the system. The user should check for any error in this portion with respect to the model definition as well as the vehicle parameters input. All vehicle input data are printed with appropriate headings for easy checking.

The second type of output consists of calculated values. An entire listing of the overall mass properties, and other parameters dependent upon C.G. location, is printed with appropriate headings if the option for centre of gravity calculation is invoked. The various matrices for the set of model state variables and the appropriate output for each solution module complete the program output.

In the case of the stability analysis, the system eigenvalues and eigenvectors are printed for each velocity. The eigenvalues of the system are given in terms of oscillation frequency and damping ratio.

In the case of the time history response, the selected outputs are printed as a function of time. The user can define as many outputs as required. The basic output variables are the lateral displacement, lateral velocity, lateral acceleration, yaw rate and yaw acceleration for each vehicle unit as well as the articulation angle between two adjacent units trailing the tractor. Other parameters can be derived from the above variables as required.

8/ PROGRAM LIMITATIONS

The number of vehicle units and the number of axles on each vehicle unit are limited by the array dimensions defined in the model. However, these limits can be changed easily as needed. The limits set in the present program permit up to six vehicle units and five axles on each unit. The maximum number of payloads allowed on each unit is 10.

Although there is no specific numbering system for the vehicle train, the order in which the vehicle is assembled and operated should be observed strictly when preparing input data.

Due to the small linear displacement assumptions made in the analysis, the program cannot be used to simulate manoeuvres in an emergency situation, where a large steer input is required at a high input frequency. It also cannot be used to simulate manoeuvres such as turning where a large change in heading would be expected.

9/ SAMPLE RUNS

Two examples are given in this section to demonstrate the input data structure of the vehicle model and the solution parameters as well as the output format of the DYNSYS package.

The first example is a linear stability analysis of a tractor semi-trailer configuration. The physical and mechanical properties of the vehicle are taken from Reference 3. It consists of a three-axle tractor and a three-axle semi-trailer. Table 2 gives the properties of the tractor semi-trailer combination. In this example, there are two vehicle units and they are numbered 1 and 2 for the tractor and the semi-trailer, respectively. The number of units is 2 and the number of equations is 4. The first five cards of the input dataset specify the solution module and its associated parameters. Cards 6 to 31 define the vehicle model. Cards 32 to 44 specify the solution module parameters. Pages 16 to 19 give the printout of the input dataset with descriptions as interpreted by the program. Pages 20 to 25 give a listing of the various matrices and the results of the stability analysis.

The second example is a time history response solution for an A-train double combination. The physical and mechanical properties of the vehicle components are also taken from Reference 3. This combination consists of a three-axle tractor with a three axle semi-trailer mounted on its fifth wheel. The second three-axle semi-trailer is mounted on a conventional two-axle A dolly which is connected to the back of the first trailer. There are a total of four units, and hence eight equations, for this vehicle combination. Pages 36 and 37 give an echo of the input dataset. The same input data with appropriate descriptions are listed on pages 38 through 41. Pages 42 to 45 give a listing of the various matrices and the result of the time history response.

```
************************** PROGRAM DYNSYS : INPUT DATA **************************
JUL 31, 1984                                                              PAGE   1
         1111111111222222222233333333334444444444555555555566666666667777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
MODEFN,KEEP                                                                  CARD    1
************SEMI COMBINATION STABILITY ANALYSIS**********************         CARD    2
 &MODPAR                                                                     CARD    3
  NOMTRX=5,NTDOF=4,NOVSET=1,NOVMAX=3,IXYZDF=1                                CARD    4
 &END                                                                        CARD    5
    3     13.41      22.35      31.29                                       CARD    6
          2          4                                                      CARD    7
          1                                                                 CARD    8
TRACTOR                                                                     CARD    9
          2          1          1                                          CARD   10
          1          2                                                     CARD   11
          1                                                                CARD   12
          2                                                                CARD   13
   6257.13   23075.5    1.6764          3          0          1            CARD   14
    2.6289                                                                CARD   15
       0.0 366986.34 29906.105   152958.        0.0                       CARD   16
    2.7686 460771.51 26683.399   152958.      .3302                       CARD   17
    4.0386 460771.51 26683.399   152958.      .3302                       CARD   18
       0.0        0.0                                                     CARD   19
          2                                                                CARD   20
SEMITRAILER                                                                 CARD   21
          1          2          1                                          CARD   22
          2                                                                CARD   23
          1          2                                                     CARD   24
          1                                                                CARD   25
  32226.46 193007.48    2.8702          3          0          1            CARD   26
       0.0                                                                CARD   27
    4.1656 426366.54 19262.841   143359.      .3302                       CARD   28
    5.2324 426366.54 19262.841   143359.      .3302                       CARD   29
    6.2992 426366.54 19262.841   143359.      .3302                       CARD   30
       0.0        0.0                                                     CARD   31
    1    2    1    1    0.0                                               CARD   32
    2    2    1    1    1.0                                               CARD   33
    3    3    1    1   -1.0                                               CARD   34
    4    3    1    1    0.0                                               CARD   35
    5    3    1    1    1.0                                               CARD   36
    0                                                                      CARD   37
EIGSOL,KEEP                                                                 CARD   38
 &EIGPAR                                                                    CARD   39
 &END                                                                       CARD   40
 &EIGCON                                                                    CARD   41
  INVEC=1                                                                   CARD   42
 &END                                                                       CARD   43
 2 2 2                                                                      CARD   44
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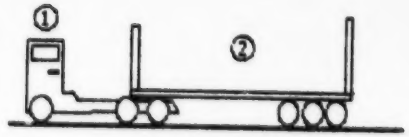


TRACTOR SEMI-TRAILER

---------- RUN PARAMETERS ----------

NUMBER OF MATRICES DEFINED	:	5
NUMBER OF DEGREES OF FREEDOM	:	4
NUMBER OF GROUND DEGREES OF FREEDOM	:	0
NUMBER OF NON-LINEAR ELEMENTS	:	0
NUMBER OF EXTERNAL FORCES	:	0
NUMBER OF EXTERNAL ACCELERATIONS	:	0
NUMBER OF OUTPUTS	:	0
NUMBER OF FREEDOM SETS	:	0
NUMBER OF NON-LINEAR EQUATION SETS	:	0
NUMBER OF EXTERNAL FORCE SETS	:	0
NUMBER OF EXTERNAL ACCELERATION SETS	:	0
NUMBER OF OUTPUT SETS	:	0
NUMBER OF MODEL PARAMETER SETS	:	1
SIZE OF LARGEST MODEL PARAMETER SET	:	3

OUTPUT TITLES READ FROM CARDS
DEGREE OF FREEDOM COORDINATES CODED BY USER
PRINTOUT TO FULL PAGE WIDTH

NAME OF MODEL PARAMETER	:	VELOCITY
UNITS OF MODEL PARAMETER	:	M/S

---------- FREEDOM SETS ----------

SET NO	NO OF MEMBS	LIST OF MEMBERS
1	4	1 2 3 4

---------- MODEL PARAMETER SETS ----------

SET NO	NO OF MEMBS	VELOCITY (M/S)		
1	3	13.41	22.35	31.29

PHYSICAL PROPERTIES OF SPRUNG MASS AND PAYLOADS OF EACH UNIT

VEHICLE UNIT 1 : TRACTOR

	MASS	MOMENT OF INERTIA
EMPTY VEHICLE	6257.13 KG	23075.50 N.M.SEC.SEC

VEHICLE TRAIN UNITS

1 2

UNITS IN LINKAGE

1

NO OF HITCHES

1

VEHICLE UNIT 2 : SEMITRAILER

	MASS	MOMENT OF INERTIA
EMPTY VEHICLE	32226.46 KG	193007.50 N.M.SEC.SEC

VEHICLE TRAIN UNITS

2

UNITS IN LINKAGE

1 2

NO OF HITCHES

1

OVERALL PHYSICAL AND DYNAMICS PROPERTIES OF EACH UNIT

VEHICLE UNIT 1 : TRACTOR

MASS = 6257.13 KG
MOMENT OF INERTIA = 23075.50 N.M.SEC.SEC
HITCH 1/CG DIST = 0.952 M
NO. OF AXLES = 3

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	-1.676 M	366986.31 N/RAD	29906.11 M.N/RAD	152958.00 N	0.0 M
AXLE 2=	1.092 M	460771.50 N/RAD	26683.40 M.N/RAD	152958.00 N	0.3302 M
AXLE 3=	2.362 M	460771.50 N/RAD	26683.40 M.N/RAD	152958.00 N	0.3302 M

VEHICLE UNIT 2 : SEMITRAILER

MASS = 32226.46 KG
MOMENT OF INERTIA = 193007.50 N.M.SEC.SEC
HITCH 1/CG DIST = 2.870 M
NO. OF AXLES = 3

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	1.295 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 2=	2.362 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 3=	3.429 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M

-- MATRIX NUMBER 1 TYPE 2 ----------
FULL MATRIX (4X 4)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	3.8484E+04	2	-3.0696E+04	3	0.0	4	-9.2496E+04
2	1	-3.0696E+04	2	5.2313E+04	3	0.0	4	8.8103E+04
3	1	0.0	2	0.0	3	1.0000E+00	4	0.0
4	1	-9.2496E+04	2	8.8103E+04	3	0.0	4	4.5849E+05

-- MATRIX NUMBER 2 TYPE 2 ----------
SPARSE MATRIX (4X 4)

ROW	COL	ELEMENT
1	3	3.2226E+04
2	3	-3.0696E+04
4	3	-9.2496E+04

-- MATRIX NUMBER 3 TYPE 3 ----------
FULL MATRIX (4X 4)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	2.5676E+06	2	-2.1948E+06	3	0.0	4	-6.6928E+06
2	1	-2.2781E+06	2	5.3880E+06	3	0.0	4	6.3748E+06
3	1	0.0	2	0.0	3	0.0	4	0.0
4	1	-6.7505E+06	2	6.4299E+06	3	0.0	4	3.6339E+07

-- MATRIX NUMBER 4 TYPE 3 ----------
FULL MATRIX (4X 4)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	0.0	2	0.0	3	1.2791E+06	4	0.0
2	1	0.0	2	0.0	3	-1.2183E+06	4	0.0
3	1	0.0	2	-1.0000E+00	3	0.0	4	1.0000E+00
4	1	0.0	2	0.0	3	-6.7505E+06	4	0.0

-- MATRIX NUMBER 5 TYPE 3 ----------
SPARSE MATRIX (4X 4)

ROW	COL	ELEMENT	COL	ELEMENT
1	2	6.2571E+03	4	3.2226E+04
2	4	-3.0696E+04		
4	4	-9.2496E+04		

---------- STATISTICS FOR MODULE MODEFN ----------

DATA STORAGE USED BY MODULE : 138 WORDS
WORK STORAGE USED BY MODULE : 16 WORDS
TOTAL STORAGE TO THIS POINT : 154 WORDS

---------- STABILITY SOLUTION PARAMETERS ----------

NUMBER OF SOLUTION CONDITIONS	: 1	
INITIAL DEFAULT FREEDOM SET	: 1	
INITIAL DEFAULT MODEL PARAMETER SET	: 1	
INITIAL DEFAULT EIGENVECTOR OPTION	: 0	
PAGE PLOT INDICATOR	: 0	
MINIMUM PAGE PLOT VELOCITY LIMIT	: 0.0	M/S
MAXIMUM PAGE PLOT VELOCITY LIMIT	: 150.0	M/S
MINIMUM PAGE PLOT DAMPING RATIO	: -0.200	
MAXIMUM PAGE PLOT DAMPING RATIO	: 0.800	
MINIMUM PAGE PLOT FREQUENCY	: 0.0	HZ
MAXIMUM PAGE PLOT FREQUENCY	: 2.5	HZ
MAXIMUM PAGE PLOT FREQUENCY FOR DAMPING PLOTS	: 20.0	HZ
MINIMUM FREQUENCY FOR EIGENVECTORS	: 0.0	HZ
MAXIMUM FREQUENCY FOR EIGENVECTORS	: 100.0	HZ

---------- EIGENVALUE SOLUTION CONDITIONS ----------

----- SOLUTION CONDITION 1

FREEDOM SET NUMBER	: 1	EIGENVECTOR INDICATOR	: 1
MODEL PARAMETER SET NUMBER	: 1		
EIGENVECTOR CALCULATION OPTIONS	: 2 2 2		

SOLUTION CONDITION 1
DEGREES OF FREEDOM : 1 2 3 4

ROOTS FOR VELOCITY 13.4 M/S

ROOT NO	FREQUENCY (HZ)	DAMPING RATIO
1	0.3514	0.8244 NP
2	0.2418	0.9774 NP

VECTORS FOR VELOCITY 13.4 M/S

ROOT 1 0.3514 HZ

ROW	REL AMP	PHASE (DEG)
1	0.78478	113.2
2	0.04511	38.7
3	0.24739	32.8
4	1.00000	0.0

ROOT 2 0.2418 HZ

ROW	REL AMP	PHASE (DEG)
1	1.00000	0.0
2	0.18344	-29.2
3	0.01668	148.3
4	0.07403	-5.0

ROOTS FOR VELOCITY 22.4 M/S

ROOT NO	FREQUENCY (HZ)	DAMPING RATIO
1	0.5362	0.5132
2	0.3925	0.8585 NP

VECTORS FOR VELOCITY 22.4 M/S

ROOT 1 0.5362 HZ

ROW	REL AMP	PHASE (DEG)
1	0.80162	59.6
2	0.06683	-36.1
3	0.24123	61.5
4	1.00000	0.0

ROOT 2 0.3925 HZ

ROW	REL AMP	PHASE (DEG)
1	1.00000	0.0
2	0.11628	-57.7
3	0.01521	102.3
4	0.09011	-18.7

ROOTS FOR VELOCITY 31.3 M/S

ROOT NO	FREQUENCY (HZ)	DAMPING RATIO
1	0.5842	0.3817
2	0.4164	0.7393

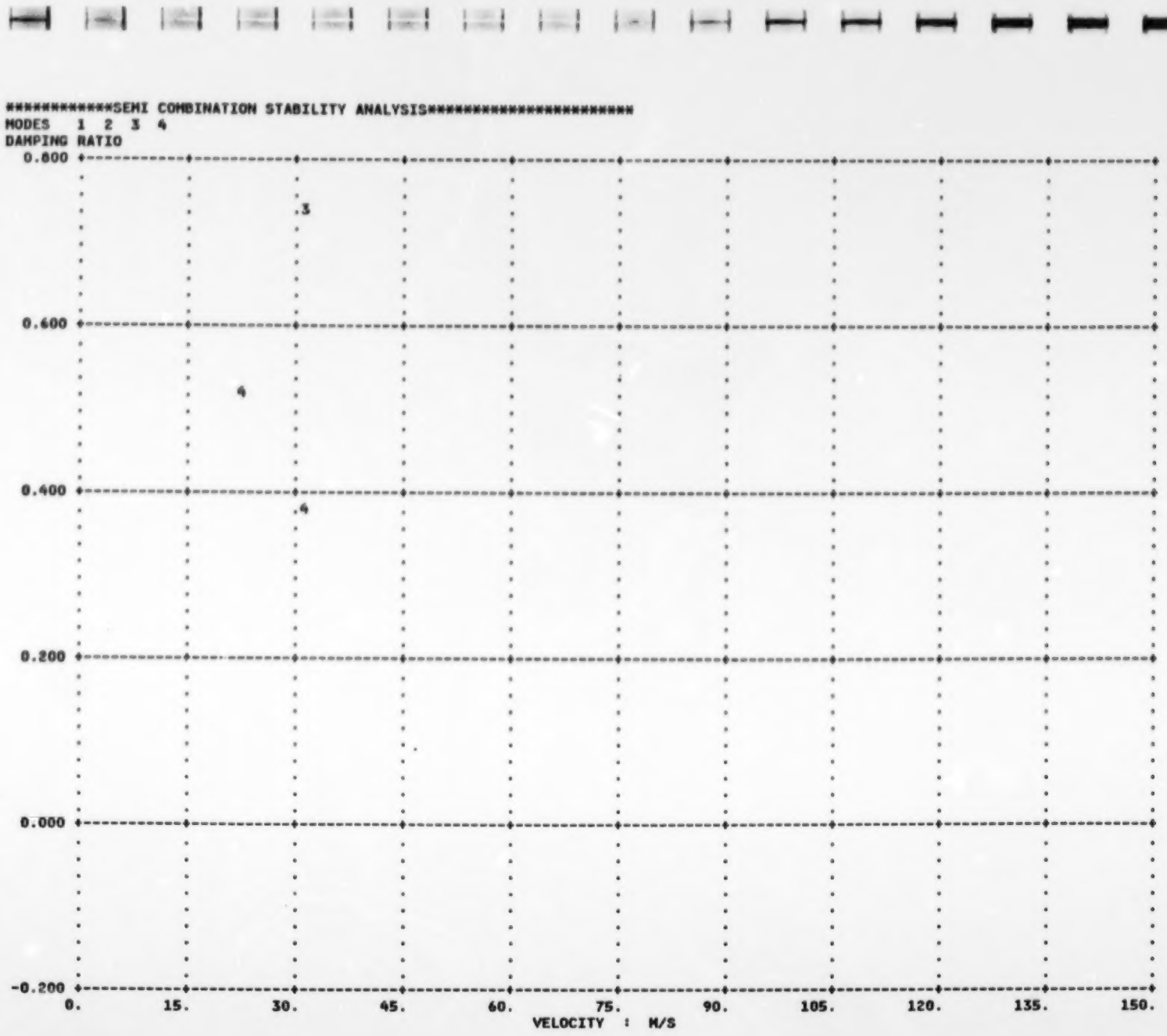
VECTORS FOR VELOCITY 31.3 M/S

ROOT 1 0.5842 HZ

ROW	REL AMP	PHASE (DEG)
1	0.99838	29.2
2	0.08188	-69.5
3	0.24536	72.1
4	1.00000	0.0

ROOT 2 0.4164 HZ

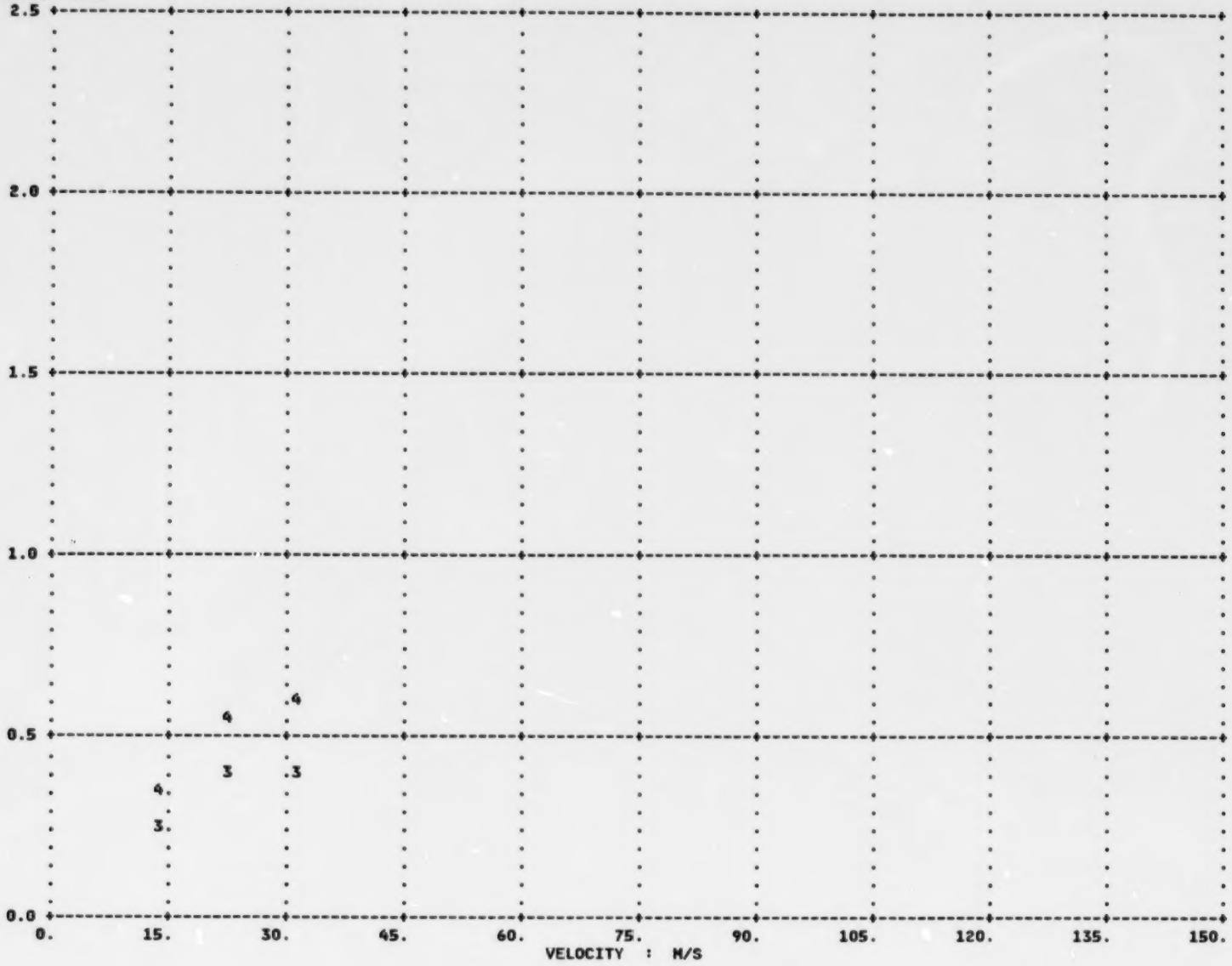
ROW	REL AMP	PHASE (DEG)
1	1.00000	0.0
2	0.08364	-67.9
3	0.01371	77.6
4	0.08829	-32.0


##########SEMI COMBINATION STABILITY ANALYSIS##########
MODES 1 2 3 4
DAMPING RATIO
0.800
0.600
0.400
0.200
0.000
-0.200
.3
4
.4
0.
15.
30.
45.
60.
75.
90.
105.
120.
135.
150.
VELOCITY : M/S

**********SEMI COMBINATION STABILITY ANALYSIS**********

MODES 1 2 3 4

FREQUENCY (HZ)



---------- STATISTICS FOR MODULE EIGSOL ----------

DATA STORAGE USED BY MODULE : 5 WORDS
WORK STORAGE USED BY MODULE : 643 WORDS
TOTAL STORAGE TO THIS POINT : 786 WORDS

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********************** PROGRAM DYNSYS : INPUT DATA **********************
JUL 31, 1984                                                        PAGE   1
         1111111111222222222233333333334444444444555555555566666666667777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
MODEFN,KEEP                                                                      CARD    1
*********TIME HISTORY OF BASELINE DOUBLE FROM LINEAR MODEL*********              CARD    2
 &MODPAR                                                                         CARD    3
  NOMTRX=9,NTDOF=9,NGDOF=1,NOVSET=1,NOVMAX=1,IXYZDF=1,NOUTPT=21                  CARD    4
 &END                                                                            CARD    5
  V1-DOT    M/SS                                                                CARD    6
  V2-DOT    M/SS                                                                CARD    7
  V3-DOT    M/SS                                                                CARD    8
  V4-DOT    M/SS                                                                CARD    9
  R1-DOT    R/SS                                                                CARD   10
 TAU1-DOT   R/S                                                                 CARD   11
  R2-DOT    R/SS                                                                CARD   12
 TAU2-DOT   R/S                                                                 CARD   13
  R3-DOT    R/SS                                                                CARD   14
 TAU3-DOT   R/S                                                                 CARD   15
  R4-DOT    R/SS                                                                CARD   16
    DY      R/S                                                                 CARD   17
    V1      M/S                                                                 CARD   18
   YAW1     R/S                                                                 CARD   19
   TAU1     RAD                                                                 CARD   20
   YAW2     R/S                                                                 CARD   21
   TAU2     RAD                                                                 CARD   22
   YAW3     R/S                                                                 CARD   23
   TAU3     RAD                                                                 CARD   24
   YAW4     R/S                                                                 CARD   25
    Y       RAD                                                                 CARD   26
    9                                                                           CARD   27
    1     23.148                                                                CARD   28
          4          8                                                          CARD   29
          1                                                                     CARD   30
TRACTOR                                                                         CARD   31
          4          1          1                                             CARD   32
          1          2          3          4                                  CARD   33
          1                                                                     CARD   34
          2                                                                     CARD   35
   6257.13   23075.5    1.6764          3          0          1                CARD   36
    2.6289                                                                      CARD   37
         0 366986.34 29906.105   152958.        0.0                             CARD   38
    2.7686 460771.51 26683.399   152958.      .3302                             CARD   39
    4.0386 460771.51 26683.399   152958.      .3302                             CARD   40
       0.0        0.0                                                          CARD   41
          2                                                                     CARD   42
SEMITRAILER                                                                     CARD   43
          3          2          2                                             CARD   44
          2          3          4                                             CARD   45
          1          2                                                        CARD   46
          1          3                                                        CARD   47
  32226.46 193007.48    2.8702          3          0          1                CARD   48
       0.0     6.7056                                                         CARD   49
    4.1656 426366.54 19262.841   143359.      .3302                             CARD   50
    5.2324 426366.54 19262.841   143359.      .3302                             CARD   51
    6.2992 426366.54 19262.841   143359.      .3302                             CARD   52
       0.0        0.0                                                          CARD   53
          3                                                                     CARD   54
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12345678901234567890123456789012345678901234567890123456789012345678901234567890
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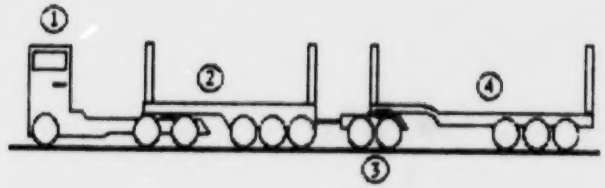

A-TRAIN DOUBLE COMBINATION

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************************** PROGRAM DYNSYS : INPUT DATA **************************
JUL 31, 1984                                                              PAGE   2
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12345678901234567890123456789012345678901234567890123456789012345678901234567890
DOLLY                                                                          CARD   55
         2         3         2                                                 CARD   56
         3         4                                                           CARD   57
         1         2         3                                                 CARD   58
         2         4                                                           CARD   59
   2851.70 2444.1884     1.778         2         0         1                   CARD   60
      0.0     1.778                                                            CARD   61
    1.2446 426366.54 19262.841   143359.     .3302                            CARD   62
    2.3114 426366.54 19262.841   143359.     .3302                            CARD   63
      0.0       0.0                                                          CARD   64
         4                                                                     CARD   65
PUP TRAILER                                                                    CARD   66
         1         4         1                                                 CARD   67
         4                                                                     CARD   68
         1         2         3         4                                       CARD   69
         3                                                                     CARD   70
  27193.56 88387.128    2.0574         3         0         1                   CARD   71
      0.0                                                                      CARD   72
    2.1082 426366.54 19262.841   143359.     .3302                            CARD   73
    3.1750 426366.54 19262.841   143359.     .3302                            CARD   74
    4.2418 426366.54 19262.841   143359.     .3302                            CARD   75
      0.0       0.0                                                          CARD   76
    1    2    1    1    0.0      A1                                          CARD   77
    2    2    1    1    1.0      A2                                          CARD   78
    3    3    1    1   -1.0      B                                           CARD   79
    4    3    1    1    0.0      B1                                          CARD   80
    5    3    1    1    1.0      B2                                          CARD   81
    6   12    1    1    0.0      VELOCITY OUTPUT                             CARD   82
    7   12    1    1    1.0      VELOCITY OUTPUT                             CARD   83
    8   13    1    1    0.0      DISPLACEMENT OUTPUT                         CARD   84
    9   13    1    1    1.0      DISPLACEMENT OUTPUT                         CARD   85
    0                                                                        CARD   86
TIMHIS                                                                         CARD   87
 &TIMPAR                                                                       CARD   88
  INCON=2,IFDISC=0                                                             CARD   89
 &END                                                                          CARD   90
0.0                .05       6.0                                             CARD   91
 &TIMCON                                                                       CARD   92
  INCON=2,IFDISC=0                                                             CARD   93
 &END                                                                          CARD   94
    1            0.0       0.0                                               CARD   95
    2            0.0       0.0                                               CARD   96
    3            0.0       0.0                                               CARD   97
    4            0.0       0.0                                               CARD   98
    5            0.0       0.0                                               CARD   99
    6            0.0       0.0                                               CARD  100
    7            0.0       0.0                                               CARD  101
    8            0.0       0.0                                               CARD  102
    0                                                                        CARD  103
         1111111111222222222233333333334444444444555555555566666666667777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

---------- RUN PARAMETERS ----------

NUMBER OF MATRICES DEFINED	: 9
NUMBER OF DEGREES OF FREEDOM	: 9
NUMBER OF GROUND DEGREES OF FREEDOM	: 1
NUMBER OF NON-LINEAR ELEMENTS	: 0
NUMBER OF EXTERNAL FORCES	: 0
NUMBER OF EXTERNAL ACCELERATIONS	: 0
NUMBER OF OUTPUTS	: 21
NUMBER OF FREEDOM SETS	: 0
NUMBER OF NON-LINEAR EQUATION SETS	: 0
NUMBER OF EXTERNAL FORCE SETS	: 0
NUMBER OF EXTERNAL ACCELERATION SETS	: 0
NUMBER OF OUTPUT SETS	: 0
NUMBER OF MODEL PARAMETER SETS	: 1
SIZE OF LARGEST MODEL PARAMETER SET	: 1

OUTPUT TITLES READ FROM CARDS
DEGREE OF FREEDOM COORDINATES CODED BY USER
PRINTOUT TO FULL PAGE WIDTH
NAME OF MODEL PARAMETER : VELOCITY
UNITS OF MODEL PARAMETER : M/S

---------- OUTPUT TITLES ----------

NO	NAME	UNITS	NO	NAME	UNITS
1	V1-DOT	M/SS	12	DY	R/S
2	V2-DOT	M/SS	13	V1	M/S
3	V3-DOT	M/SS	14	YAW1	R/S
4	V4-DOT	M/SS	15	TAU1	RAD
5	R1-DOT	R/SS	16	YAW2	R/S
6	TAU1-DOT	R/S	17	TAU2	RAD
7	R2-DOT	R/SS	18	YAW3	R/S
8	TAU2-DOT	R/S	19	TAU3	RAD
9	R3-DOT	R/SS	20	YAW4	R/S
10	TAU3-DOT	R/S	21	Y	RAD
11	R4-DOT	R/SS			

---------- LIST OF GROUND DEGREES OF FREEDOM ----------

9

---------- FREEDOM SETS ----------

SET NO OF NO MEMBS	---------- LIST OF MEMBERS ----------
1 9	1 2 3 4 5 6 7 8 9

---------- OUTPUT SETS ----------

SET NO OF NO MEMBS	---------- LIST OF MEMBERS ----------
1 21	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

---------- MODEL PARAMETER SETS ----------

SET NO OF NO MEMBS	---------- VELOCITY (M/S) ----------
1 1	23.15

PHYSICAL PROPERTIES OF SPRUNG MASS AND PAYLOADS OF EACH UNIT

VEHICLE UNIT 1 : TRACTOR

	MASS	MOMENT OF INERTIA
EMPTY VEHICLE	6257.13 KG	23075.50 N.M.SEC.SEC

VEHICLE TRAIN UNITS
1 2 3 4

UNITS IN LINKAGE
1

NO OF HITCHES
1

VEHICLE UNIT 2 : SEMITRAILER

	MASS	MOMENT OF INERTIA
EMPTY VEHICLE	32226.46 KG	193007.50 N.M.SEC.SEC

VEHICLE TRAIN UNITS
2 3 4

UNITS IN LINKAGE
1 2

NO OF HITCHES
2

VEHICLE UNIT 3 : DOLLY

	MASS	MOMENT OF INERTIA
EMPTY VEHICLE	2051.70 KG	2444.19 N.M.SEC.SEC

VEHICLE TRAIN UNITS
3 4

UNITS IN LINKAGE
1 2 3

NO OF HITCHES
****

2

VEHICLE UNIT 4 : PUP TRAILER
****

	MASS	MOMENT OF INERTIA
	****	**********
EMPTY VEHICLE	27193.56 KG	88387.12 N.M.SEC.SEC

VEHICLE TRAIN UNITS
****

4

UNITS IN LINKAGE
****

1 2 3 4

NO OF HITCHES
****

1

OVERALL PHYSICAL AND DYNAMICS PROPERTIES OF EACH UNIT

VEHICLE UNIT 1 : TRACTOR

MASS = 6257.13 KG
MOMENT OF INERTIA = 23075.50 N.M.SEC.SEC
HITCH 1/CG DIST = 0.952 M
NO. OF AXLES = 3

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	-1.676 M	366986.31 N/RAD	29906.11 M.N/RAD	152958.00 N	0.0 M
AXLE 2=	1.092 M	460771.50 N/RAD	26683.40 M.N/RAD	152958.00 N	0.3302 M
AXLE 3=	2.362 M	460771.50 N/RAD	26683.40 M.N/RAD	152958.00 N	0.3302 M

VEHICLE UNIT 2 : SEMITRAILER

MASS = 32226.46 KG
MOMENT OF INERTIA = 193007.50 N.M.SEC.SEC
HITCH 1/CG DIST = 2.870 M
HITCH 2/CG DIST = 3.835 M
NO. OF AXLES = 3

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	1.295 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 2=	2.362 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 3=	3.429 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M

VEHICLE UNIT 3 : DOLLY

MASS = 2051.70 KG
MOMENT OF INERTIA = 2444.19 N.M.SEC.SEC
HITCH 1/CG DIST = 1.778 M
HITCH 2/CG DIST = 0.0 M
NO. OF AXLES = 2

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	-0.533 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 2=	0.533 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M

VEHICLE UNIT 4 : PUP TRAILER

MASS = 27193.56 KG
MOMENT OF INERTIA = 88387.12 N.M.SEC.SEC
HITCH 1/CG DIST = 2.057 M
NO. OF AXLES = 3

	AXLE/CG DIST	CORNER STIFFNESS	ALIGNING TORQUE	CIRCUMF STIFFNESS	DUAL TIRE DIST
AXLE 1=	0.051 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 2=	1.118 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M
AXLE 3=	2.184 M	426366.56 N/RAD	19262.84 M.N/RAD	143359.00 N	0.3302 M

A1

FULL MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	6.7729E+04	2	-5.8552E+04	3	0.0	4	-2.8860E+05	5	0.0	6	-5.1998E+04	7	0.0
	8	-5.5948E+04	9	0.0										
2	1	-5.8552E+04	2	7.8846E+04	3	0.0	4	2.7489E+05	5	0.0	6	4.9528E+04	7	0.0
	8	5.3290E+04	9	0.0										
3	1	0.0	2	0.0	3	1.0000E+00	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										
4	1	-2.8860E+05	2	2.7489E+05	3	0.0	4	1.7735E+06	5	0.0	6	3.4868E+05	7	0.0
	8	3.7517E+05	9	0.0										
5	1	0.0	2	0.0	3	0.0	4	0.0	5	1.0000E+00	6	0.0	7	0.0
	8	0.0	9	0.0										
6	1	-5.1998E+04	2	4.9528E+04	3	0.0	4	3.4868E+05	5	0.0	6	9.4897E+04	7	0.0
	8	9.9476E+04	9	0.0										
7	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	1.0000E+00
	8	0.0	9	0.0										
8	1	-5.5948E+04	2	5.3290E+04	3	0.0	4	3.7516E+05	5	0.0	6	9.9476E+04	7	0.0
	8	2.0349E+05	9	0.0										
9	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										

A2

SPARSE MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	3	6.1472E+04	5	2.9245E+04	7	2.7194E+04
2	3	-5.8552E+04	5	-2.7856E+04	7	-2.5902E+04
4	3	-2.8860E+05	5	-1.9611E+05	7	-1.8235E+05
6	3	-5.1998E+04	5	-5.1998E+04	7	-4.8350E+04
8	3	-5.5948E+04	5	-5.5948E+04	7	-5.5948E+04

B

FULL MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	4.6995E+06	2	-4.2254E+06	3	0.0	4	-2.0988E+07	5	0.0	6	-3.7904E+06	7	0.0
	8	-4.0611E+06	9	0.0										
2	1	-4.3087E+06	2	7.3221E+06	3	0.0	4	1.9991E+07	5	0.0	6	3.6103E+06	7	0.0
	8	3.8682E+06	9	0.0										
3	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										
4	1	-2.1046E+07	2	2.0046E+07	3	0.0	4	1.3220E+08	5	0.0	6	2.5417E+07	7	0.0
	8	2.7232E+07	9	0.0										
5	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										
6	1	-3.8289E+06	2	3.6470E+06	3	0.0	4	2.5675E+07	5	0.0	6	7.0817E+06	7	0.0
	8	7.2207E+06	9	0.0										
7	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										
8	1	-4.1189E+06	2	3.9233E+06	3	0.0	4	2.7620E+07	5	0.0	6	7.3234E+06	7	0.0
	8	1.4095E+07	9	0.0										
9	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										

B1

FULL MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	0.0	2	0.0	3	3.4109E+06	4	0.0	5	2.1318E+06	6	0.0	7	1.2791E+06

B1 ----------CONTINUED

FULL MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
	8	0.0	9	-3.6699E+05										
2	1	0.0	2	0.0	3	-3.2489E+06	4	0.0	5	-2.0306E+06	6	0.0	7	-1.2183E+06
	8	0.0	9	-5.8531E+05										
3	1	0.0	2	-1.0000E+00	3	0.0	4	1.0000E+00	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										
4	1	0.0	2	0.0	3	-2.1046E+07	4	0.0	5	-1.4295E+07	6	0.0	7	-8.5771E+06
	8	0.0	9	0.0										
5	1	0.0	2	0.0	3	0.0	4	-1.0000E+00	5	0.0	6	1.0000E+00	7	0.0
	8	0.0	9	0.0										
6	1	0.0	2	0.0	3	-3.8289E+06	4	0.0	5	-3.8289E+06	6	0.0	7	-2.2742E+06
	8	0.0	9	0.0										
7	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	-1.0000E+00	7	0.0
	8	1.0000E+00	9	0.0										
8	1	0.0	2	0.0	3	-4.1189E+06	4	0.0	5	-4.1189E+06	6	0.0	7	-4.1189E+06
	8	0.0	9	0.0										
9	1	0.0	2	0.0	3	0.0	4	0.0	5	0.0	6	0.0	7	0.0
	8	0.0	9	0.0										

B2 ----------

SPARSE MATRIX (9X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	2	6.2571E+03	4	3.2226E+04	6	2.0517E+03	8	2.7194E+04
2	4	-3.0696E+04	6	-1.9542E+03	8	-2.5902E+04		
4	4	-9.2496E+04	6	-1.3758E+04	8	-1.8235E+05		
6	6	-3.6479E+03	8	-4.8350E+04				
8	8	-5.5948E+04						

VELOCITY OUTPUT ----------

SPARSE MATRIX (21X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
1	1	1.0000E+00								
2	1	1.0000E+00	2	-9.5250E-01	4	-2.8702E+00				
3	1	1.0000E+00	2	-9.5250E-01	4	-6.7056E+00	6	-1.7780E+00		
4	1	1.0000E+00	2	-9.5250E-01	4	-6.7056E+00	6	-1.7780E+00	8	-2.0574E+00
5	2	1.0000E+00								
6	3	1.0000E+00								
7	4	1.0000E+00								
8	5	1.0000E+00								
9	6	1.0000E+00								
10	7	1.0000E+00								
11	8	1.0000E+00								
12	9	1.0000E+00								

VELOCITY OUTPUT ----------

SPARSE MATRIX (21X 9)

ROW	COL	ELEMENT	COL	ELEMENT	COL	ELEMENT
2	3	1.0000E+00				
3	3	1.0000E+00	5	1.0000E+00		
4	3	1.0000E+00	5	1.0000E+00	7	1.0000E+00

DISPLACEMENT OUTPUT ----------

SPARSE MATRIX (21X 9)

ROW	COL	ELEMENT
13	1	1.0000E+00

DISPLACEMENT OUTPUT ----------CONTINUED

SPARSE MATRIX (21X 9)

ROW	COL	ELEMENT
14	2	1.0000E+00
15	3	1.0000E+00
16	4	1.0000E+00
17	5	1.0000E+00
18	6	1.0000E+00
19	7	1.0000E+00
20	8	1.0000E+00
21	9	1.0000E+00

DISPLACEMENT OUTPUT ----------

SPARSE MATRIX (21X 9)

ROW	COL	ELEMENT
1	2	1.0000E+00
2	4	1.0000E+00
3	6	1.0000E+00
4	8	1.0000E+00

---------- STATISTICS FOR MODULE MODEFN ----------

DATA STORAGE USED BY MODULE : 647 WORDS
WORK STORAGE USED BY MODULE : 189 WORDS
TOTAL STORAGE TO THIS POINT : 836 WORDS

---------- TIME HISTORY SOLUTION PARAMETERS ----------

TIME INPUT METHOD	:	2
NUMBER OF TIME INTERVALS	:	2
NUMBER OF TIME INTERVAL-INCREMENTS	:	1
NUMBER OF SOLUTION CONDITIONS	:	1
INITIAL DEFAULT FREEDOM SET	:	1
INITIAL DEFAULT NON-LINEAR EQUATION SET	:	1
INITIAL DEFAULT EXTERNAL FORCE SET	:	1
INITIAL DEFAULT EXTERNAL ACCELERATION SET	:	1
INITIAL DEFAULT OUTPUT SET	:	1
INITIAL DEFAULT MODEL PARAMETER SET	:	1
INITIAL DEFAULT INITIAL CONDITION INPUT	:	2
INITIAL DEFAULT INTEGRATION METHOD	:	2
INITIAL DEFAULT INTEGRATION TOLERANCE	:	1.000E-04
INITIAL DEFAULT DISC OUTPUT INDICATOR	:	0

---------- TIME HISTORY SOLUTION DATA ----------

---------- LIST OF SOLUTION TIMES ----------

0.0	0.05000	0.10000	0.15000	0.20000	0.25000	0.30000	0.35000
0.40000	0.45000	0.50000	0.55000	0.60000	0.65000	0.70000	0.75000
0.80000	0.85000	0.90000	0.95000	1.00000	1.05000	1.10000	1.15000
1.20000	1.25000	1.30000	1.35000	1.40000	1.45000	1.50000	1.55000
1.60000	1.65000	1.70000	1.75000	1.80000	1.85000	1.90000	1.95000
2.00000	2.05000	2.10000	2.15000	2.20000	2.25000	2.30000	2.35000
2.40000	2.45000	2.50000	2.55000	2.60000	2.65000	2.70000	2.75000
2.80000	2.85000	2.90000	2.95000	3.00000	3.05000	3.10000	3.15000
3.20000	3.25000	3.30000	3.35000	3.40000	3.45000	3.50000	3.55000
3.60000	3.65000	3.70000	3.75000	3.80000	3.85000	3.90000	3.95000
4.00000	4.05000	4.10000	4.15000	4.20000	4.25000	4.30000	4.35000
4.40000	4.45000	4.50000	4.55000	4.60000	4.65000	4.70000	4.75000
4.80000	4.85000	4.90000	4.95000	5.00000	5.05000	5.10000	5.15000
5.20000	5.25000	5.30000	5.35000	5.40000	5.45000	5.50000	5.55000
5.60000	5.65000	5.70000	5.75000	5.80000	5.85000	5.90000	5.95000
6.00000							

---------- TIME HISTORY SOLUTION CONDITIONS ----------

----- SOLUTION CONDITION 1

FREEDOM SET NUMBER	:	1	OUTPUT SET NUMBER	:	1
NON-LINEAR EQUATION SET NUMBER	:	1	MODEL PARAMETER SET NUMBER	:	1
EXTERNAL FORCE SET NUMBER	:	1	INITIAL CONDITION INPUT FORMAT	:	2
EXTERNAL ACCELERATION SET NUMBER	:	1	INTEGRATION METHOD	:	2
DISC OUTPUT INDICATOR	:	0	INTEGRATION TOLERANCE	:	1.0E-04

---------- INITIAL CONDITIONS ----------

DOF	POSITION	VELOCITY	DOF	POSITION	VELOCITY
1	0.0	0.0	6	0.0	0.0
2	0.0	0.0	7	0.0	0.0
3	0.0	0.0	8	0.0	0.0
4	0.0	0.0	9	0.0	0.0
5	0.0	0.0			

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	V1-DOT	V2-DOT	V3-DOT	V4-DOT	R1-DOT	TAU1-DOT	R2-DOT	TAU2-DOT	R3-DOT	TAU3-DOT
UNITS	M/SS	M/SS	M/SS	M/SS	R/SS	R/S	R/SS	R/S	R/SS	R/S
TIME (SEC)										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.050	6.4017E-02	6.6635E-03	-2.6877E-04	-1.1672E-04	5.0981E-02	-2.4461E-19	3.0640E-03	-4.8495E-20	-2.7107E-03	5.9783E-21
0.100	1.2014E-01	1.5223E-02	-7.8757E-04	-3.4453E-04	8.9712E-02	2.0676E-03	6.7835E-03	3.0347E-04	-5.6283E-03	-1.3372E-04
0.150	1.7555E-01	2.8152E-02	-1.9842E-03	-8.8139E-04	1.1852E-01	5.5933E-03	1.2021E-02	9.8527E-04	-8.9816E-03	-4.1327E-04
0.200	2.3497E-01	4.7111E-02	-4.2406E-03	-1.9187E-03	1.3943E-01	1.0045E-02	1.9180E-02	2.1498E-03	-1.2493E-02	-8.4400E-04
0.250	3.0133E-01	7.3214E-02	-7.8622E-03	-3.6359E-03	1.5415E-01	1.4973E-02	2.8322E-02	3.8884E-03	-1.5496E-02	-1.4032E-03
0.300	3.7620E-01	1.0720E-01	-1.3001E-02	-6.1695E-03	1.6410E-01	2.0010E-02	3.9264E-02	6.2492E-03	-1.7091E-02	-2.0264E-03
0.350	3.9618E-01	1.4291E-01	-1.9291E-02	-9.4536E-03	1.1946E-01	2.4864E-02	4.8597E-02	9.2196E-03	-1.3603E-02	-2.6035E-03
0.400	4.3317E-01	1.8544E-01	-2.6312E-02	-1.3409E-02	8.4414E-02	2.7250E-02	5.8297E-02	1.2417E-02	-6.6584E-03	-2.8500E-03
0.450	4.7955E-01	2.3251E-01	-3.2787E-02	-1.7573E-02	5.7371E-02	2.7625E-02	6.7025E-02	1.5626E-02	4.6300E-03	-2.5754E-03
0.500	5.2983E-01	2.8256E-01	-3.7047E-02	-2.1270E-02	3.6898E-02	2.6425E-02	7.3905E-02	1.8551E-02	2.0336E-02	-1.5876E-03
0.550	5.8031E-01	3.3449E-01	-3.7076E-02	-2.3590E-02	2.1730E-02	2.4052E-02	7.8435E-02	2.0881E-02	3.9786E-02	2.6463E-04
0.600	6.2854E-01	3.8748E-01	-3.0643E-02	-2.3414E-02	1.0776E-02	2.0867E-02	8.0410E-02	2.2332E-02	6.1708E-02	3.0557E-03
0.650	6.7301E-01	4.4086E-01	-1.5503E-02	-1.9461E-02	3.1128E-03	1.7186E-02	7.9850E-02	2.2695E-02	8.4427E-02	6.7601E-03
0.700	7.1296E-01	4.9407E-01	1.0381E-02	-1.0362E-02	-2.0258E-03	1.3275E-02	7.6936E-02	2.1853E-02	1.0608E-01	1.1243E-02
0.750	6.8409E-01	5.3991E-01	4.8889E-02	5.3692E-03	-5.6248E-02	9.3554E-03	6.8901E-02	1.9795E-02	1.2753E-01	1.6264E-02
0.800	6.5836E-01	5.8263E-01	1.0100E-01	2.9003E-02	-9.6827E-02	5.5355E-03	5.8517E-02	1.6311E-02	1.4465E-01	2.1630E-02
0.850	6.2887E-01	6.1927E-01	1.6740E-01	6.1827E-02	-1.2649E-01	-3.4413E-03	4.5321E-02	1.151[illegible]E-02	1.5638E-01	2.6966E-02
0.900	5.9128E-01	6.4770E-01	2.4789E-01	1.0485E-01	-1.4757E-01	-1.0947E-02	2.9316E-02	5.5552E-03	1.6163E-01	3.1865E-02
0.950	5.4314E-01	6.6635E-01	3.4137E-01	1.5871E-01	-1.6200E-01	-1.8469E-02	1.0835E-02	-1.3459E-03	1.5941E-01	3.5902E-02
1.000	4.8335E-01	6.7407E-01	4.4584E-01	2.2362E-01	-1.7139E-01	-2.5605E-02	-9.5731E-03	-8.9087E-03	1.4902E-01	3.8658E-02
1.050	4.1175E-01	6.7002E-01	5.5837E-01	2.9923E-01	-1.7703E-01	-3.2058E-02	-3.1237E-02	-1.6796E-02	1.3018E-01	3.9750E-02
1.100	3.2879E-01	6.5357E-01	6.7525E-01	3.8462E-01	-1.7995E-01	-3.7621E-02	-5.3441E-02	-2.4632E-02	1.0309E-01	3.8854E-02
1.150	2.3531E-01	6.2431E-01	7.9204E-01	4.7822E-01	-1.8096E-01	-4.2171E-02	-7.5477E-02	-3.2031E-02	6.8477E-02	3.5741E-02
1.200	1.3236E-01	5.8200E-01	9.0383E-01	5.7783E-01	-1.8069E-01	-4.5653E-02	-9.6695E-02	-3.8620E-02	2.7578E-02	3.0300E-02
1.250	2.1072E-02	5.2658E-01	1.0054E+00	6.8066E-01	-1.7959E-01	-4.8071E-02	-1.1652E-01	-4.4069E-02	-1.7951E-02	2.2553E-02
1.300	-9.7445E-02	4.5814E-01	1.0915E+00	7.8334E-01	-1.7802E-01	-4.9474E-02	-1.3449E-01	-4.8113E-02	-6.6126E-02	1.2668E-02
1.350	-1.5811E-01	3.8361E-01	1.1570E+00	8.8201E-01	-1.2524E-01	-4.9948E-02	-1.4718E-01	-5.0571E-02	-1.1749E-01	9.5395E-04
1.400	-2.3187E-01	2.9867E-01	1.1973E+00	9.7257E-01	-8.4657E-02	-4.7536E-02	-1.5675E-01	-5.1055E-02	-1.6731E-01	-1.2283E-02
1.450	-3.1068E-01	2.0635E-01	1.2084E+00	1.0506E+00	-5.4046E-02	-4.2974E-02	-1.6220E-01	-4.9503E-02	-2.1370E-01	-2.6509E-02
1.500	-3.8907E-01	1.0903E-01	1.1871E+00	1.1118E+00	-3.1462E-02	-3.6930E-02	-1.6310E-01	-4.5922E-02	-2.5451E-01	-4.1105E-02
1.550	-4.6349E-01	8.6738E-03	1.1315E+00	1.1518E+00	-1.5234E-02	-2.9992E-02	-1.5945E-01	-4.0416E-02	-2.8754E-01	-5.5385E-02
1.600	-5.3183E-01	-9.3047E-02	1.0408E+00	1.1671E+00	-3.9501E-03	-2.2661E-02	-1.5157E-01	-3.3206E-02	-3.1079E-01	-6.8623E-02
1.650	-5.9304E-01	-1.9461E-01	9.1605E-01	1.1544E+00	3.5573E-03	-1.5355E-02	-1.3999E-01	-2.4622E-02	-3.2268E-01	-8.0086E-02
1.700	-6.4678E-01	-2.9462E-01	7.5939E-01	1.1116E+00	8.2403E-03	-8.4030E-03	-1.2543E-01	-1.5093E-02	-3.2224E-01	-8.9086E-02
1.750	-6.2922E-01	-3.8512E-01	5.7433E-01	1.0371E+00	6.1844E-02	-2.0590E-03	-1.0557E-01	-5.1141E-03	-3.1189E-01	-9.5011E-02
1.800	-6.1273E-01	-4.6965E-01	3.6597E-01	9.3094E-01	1.0174E-01	5.5658E-03	-8.3613E-02	5.0869E-03	-2.8962E-01	-9.7518E-02
1.850	-5.9082E-01	-5.4467E-01	1.4003E-01	7.9382E-01	1.3072E-01	1.3748E-02	-5.9457E-02	1.5059E-02	-2.5684E-01	-9.6312E-02
1.900	-5.5947E-01	-6.0755E-01	-9.6907E-02	6.2778E-01	1.5115E-01	2.1900E-02	-3.3406E-02	2.4419E-02	-2.1514E-01	-9.1289E-02
1.950	-5.1651E-01	-6.5638E-01	-3.3769E-01	4.3603E-01	1.6501E-01	2.9564E-02	-6.0283E-03	3.2846E-02	-1.6624E-01	-8.2528E-02
2.000	-4.6110E-01	-6.8977E-01	-5.7494E-01	2.2282E-01	1.7391E-01	3.6403E-02	2.1958E-02	4.0072E-02	-1.1195E-01	-7.0286E-02
2.050	-4.5727E-01	-7.1344E-01	-8.0102E-01	-6.4707E-03	1.2817E-01	4.2192E-02	4.6715E-02	4.5887E-02	-5.1512E-02	-5.4978E-02
2.100	-4.3374E-01	-7.2202E-01	-1.0089E+00	-2.4578E-01	9.2051E-02	4.4735E-02	6.9892E-02	4.9840E-02	1.0579E-02	-3.7020E-02
2.150	-3.9862E-01	-7.1772E-01	-1.1916E+00	-4.8822E-01	6.4014E-02	4.4595E-02	8.9933E-02	5.1768E-02	7.2526E-02	-1.7061E-02
2.200	-3.5778E-01	-7.0221E-01	-1.3430E+00	-7.2648E-01	4.2658E-02	4.2324E-02	1.0585E-01	5.1551E-02	1.3208E-01	4.1614E-03
2.250	-3.1531E-01	-6.7688E-01	-1.4580E+00	-9.5312E-01	2.6729E-02	3.8445E-02	1.1710E-01	4.9149E-02	1.8672E-01	2.5831E-02
2.300	-2.7393E-01	-6.4299E-01	-1.5328E+00	-1.1608E+00	1.5137E-02	3.3439E-02	1.2356E-01	4.4633E-02	2.3391E-01	4.7076E-02
2.350	-2.3535E-01	-6.0179E-01	-1.5650E+00	-1.3428E+00	6.9478E-03	2.7737E-02	1.2536E-01	3.8200E-02	2.7130E-01	6.7000E-02
2.400	-2.0050E-01	-5.5454E-01	-1.5539E+00	-1.4929E+00	1.3807E-03	2.1712E-02	1.2289E-01	3.0164E-02	2.9699E-01	8.4718E-02
2.450	-1.6978E-01	-5.0255E-01	-1.5006E+00	-1.6060E+00	-2.2079E-03	1.5681E-02	1.1667E-01	2.0944E-02	3.0969E-01	9.9407E-02
2.500	-1.4322E-01	-4.4716E-01	-1.4079E+00	-1.6784E+00	-4.3390E-03	9.9006E-03	1.0733E-01	1.1037E-02	3.0881E-01	1.1035E-01

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	V1-DOT	V2-DOT	V3-DOT	V4-DOT	R1-DOT	TAU1-DOT	R2-DOT	TAU2-DOT	R3-DOT	TAU3-DOT
UNITS	M/SS	M/SS	M/SS	M/SS	R/SS	R/S	R/SS	R/S	R/SS	R/S
TIME (SEC)										
2.550	-1.2040E-01	-3.8972E-01	-1.2800E+00	-1.7076E+00	-5.4273E-03	4.5718E-03	9.5566E-02	9.7928E-04	2.9457E-01	1.1698E-01
2.600	-1.0156E-01	-3.3158E-01	-1.1227E+00	-1.6929E+00	-5.7970E-03	-1.5782E-04	8.2066E-02	-8.6851E-03	2.6792E-01	1.1893E-01
2.650	-8.5661E-02	-2.7402E-01	-9.4289E-01	-1.6349E+00	-5.6967E-03	-4.1893E-03	6.7517E-02	-1.7445E-02	2.3055E-01	1.1605E-01
2.700	-7.2448E-02	-2.1823E-01	-7.4816E-01	-1.5362E+00	-5.3127E-03	-7.4676E-03	5.2555E-02	-2.4853E-02	1.8468E-01	1.0842E-01
2.750	-6.1470E-02	-1.6529E-01	-5.4654E-01	-1.4004E+00	-4.7810E-03	-9.9764E-03	3.7757E-02	-3.0557E-02	1.3298E-01	9.6366E-02
2.800	-5.2312E-02	-1.1612E-01	-3.4602E-01	-1.2328E+00	-4.1975E-03	-1.1732E-02	2.3624E-02	-3.4316E-02	7.8343E-02	8.0437E-02
2.850	-4.4605E-02	-7.1488E-02	-1.5418E-01	-1.0395E+00	-3.6268E-03	-1.2777E-02	1.0570E-02	-3.6011E-02	2.3709E-02	6.1379E-02
2.900	-3.8034E-02	-3.1975E-02	2.2143E-02	-8.2774E-01	-3.1091E-03	-1.3176E-02	-1.0790E-03	-3.5653E-02	-2.8110E-02	4.0098E-02
2.950	-3.2336E-02	2.0263E-03	1.7718E-01	-6.0502E-01	-2.6667E-03	-1.3008E-02	-1.1087E-02	-3.3370E-02	-7.4597E-02	1.7609E-02
3.000	-2.7306E-02	3.0309E-02	3.0646E-01	-3.7919E-01	-2.3082E-03	-1.2365E-02	-1.9307E-02	-2.9396E-02	-1.1367E-01	-5.0226E-03
3.050	-2.2784E-02	5.2844E-02	4.0693E-01	-1.5794E-01	-2.0327E-03	-1.1341E-02	-2.5675E-02	-2.4053E-02	-1.4377E-01	-2.6737E-02
3.100	-1.8657E-02	6.9771E-02	4.7707E-01	5.1426E-02	-1.8331E-03	-1.0033E-02	-3.0201E-02	-1.7722E-02	-1.6393E-01	-4.6539E-02
3.150	-1.4849E-02	8.1376E-02	5.1683E-01	2.4234E-01	-1.6980E-03	-8.5346E-03	-3.2962E-02	-1.0822E-02	-1.7381E-01	-6.3550E-02
3.200	-1.1316E-02	8.8072E-02	5.2756E-01	4.0919E-01	-1.6140E-03	-6.9344E-03	-3.4092E-02	-3.7781E-03	-1.7364E-01	-7.7054E-02
3.250	-8.0377E-03	9.0377E-02	5.1183E-01	5.4751E-01	-1.5667E-03	-5.3116E-03	-3.3768E-02	3.0019E-03	-1.6420E-01	-8.6530E-02
3.300	-5.0135E-03	8.8880E-02	4.7326E-01	6.5413E-01	-1.5424E-03	-3.7354E-03	-3.2201E-02	9.1512E-03	-1.4672E-01	-9.1677E-02
3.350	-2.2551E-03	8.4224E-02	4.1618E-01	7.2730E-01	-1.5285E-03	-2.2628E-03	-2.9623E-02	1.4363E-02	-1.2280E-01	-9.2424E-02
3.400	2.1824E-04	7.7070E-02	3.4545E-01	7.6663E-01	-1.5139E-03	-9.3877E-04	-2.6273E-02	1.8405E-02	-9.4271E-02	-8.8923E-02
3.450	2.3850E-03	6.8080E-02	2.6611E-01	7.7309E-01	-1.4898E-03	2.0449E-04	-2.2394E-02	2.1127E-02	-6.3072E-02	-8.1533E-02
3.500	4.2247E-03	5.7889E-02	1.8314E-01	7.4894E-01	-1.4495E-03	1.1470E-03	-1.8216E-02	2.2466E-02	-3.1148E-02	-7.0795E-02
3.550	5.7219E-03	4.7089E-02	1.0119E-01	6.9748E-01	-1.3887E-03	1.8801E-03	-1.3952E-02	2.2440E-02	-3.3068E-04	-5.7395E-02
3.600	6.8677E-03	3.6208E-02	2.4400E-02	6.2293E-01	-1.3053E-03	2.4054E-03	-9.7893E-03	2.1148E-02	2.7758E-02	-4.2120E-02
3.650	7.6618E-03	2.5705E-02	-4.3772E-02	5.3020E-01	-1.1992E-03	2.7332E-03	-5.8885E-03	1.8749E-02	5.1779E-02	-2.5813E-02
3.700	8.1134E-03	1.5955E-02	-1.0049E-01	4.2457E-01	-1.0722E-03	2.8811E-03	-2.3762E-03	1.5459E-02	7.0728E-02	-9.3251E-03
3.750	8.2411E-03	7.2469E-03	-1.4456E-01	3.1153E-01	-9.2746E-04	2.8720E-03	6.5417E-04	1.1526E-02	8.3970E-02	6.5287E-03
3.800	8.0721E-03	-2.1511E-04	-1.7450E-01	1.9646E-01	-7.6944E-04	2.7322E-03	3.1427E-03	7.2183E-03	9.1241E-02	2.1011E-02
3.850	7.6420E-03	-6.3107E-03	-1.9043E-01	8.4422E-02	-6.0331E-04	2.4904E-03	5.0614E-03	2.8050E-03	9.2636E-02	3.3496E-02
3.900	6.9921E-03	-1.0997E-02	-1.9307E-01	-2.0023E-02	-4.3467E-04	2.1753E-03	6.4117E-03	-1.4576E-03	8.8572E-02	4.3496E-02
3.950	6.1688E-03	-1.4298E-02	-1.8376E-01	-1.1302E-01	-2.6920E-04	1.8148E-03	7.2202E-03	-5.3405E-03	7.9738E-02	5.0680E-02
4.000	5.2207E-03	-1.6299E-02	-1.6439E-01	-1.9151E-01	-1.1232E-04	1.4345E-03	7.5349E-03	-8.6531E-03	6.7038E-02	5.4880E-02
4.050	4.1970E-03	-1.7129E-02	-1.3718E-01	-2.5334E-01	3.1074E-05	1.0570E-03	7.4198E-03	-1.1251E-02	5.1516E-02	5.6091E-02
4.100	3.1457E-03	-1.6952E-02	-1.0458E-01	-2.9729E-01	1.5687E-04	7.0121E-04	6.9501E-03	-1.3040E-02	3.4290E-02	5.4459E-02
4.150	2.1111E-03	-1.5955E-02	-6.9070E-02	-3.2303E-01	2.6188E-04	3.8187E-04	6.2073E-03	-1.3980E-02	1.6483E-02	5.0268E-02
4.200	1.1329E-03	-1.4333E-02	-3.3063E-02	-3.3111E-01	3.4395E-04	1.0945E-04	5.2744E-03	-1.4079E-02	-8.4335E-04	4.3911E-02
4.250	2.4469E-04	-1.2283E-02	1.2558E-03	-3.2285E-01	4.0203E-04	-1.0975E-04	4.2315E-03	-1.3394E-02	-1.6743E-02	3.5867E-02
4.300	-5.2716E-04	-9.9911E-03	3.2014E-02	-3.0020E-01	4.3616E-04	-2.7330E-04	3.1526E-03	-1.2019E-02	-3.0426E-02	2.6666E-02
4.350	-1.1638E-03	-7.6245E-03	5.7733E-02	-2.6562E-01	4.4736E-04	-3.8226E-04	2.1025E-03	-1.0082E-02	-4.1294E-02	1.6862E-02
4.400	-1.6543E-03	-5.3285E-03	7.7364E-02	-2.2193E-01	4.3757E-04	-4.4055E-04	1.1349E-03	-7.7318E-03	-4.8957E-02	6.9972E-03
4.450	-1.9950E-03	-3.2204E-03	9.0318E-02	-1.7210E-01	4.0946E-04	-4.5437E-04	2.9105E-04	-5.1277E-03	-5.3236E-02	-2.4205E-03
4.500	-2.1894E-03	-1.3878E-03	9.6444E-02	-1.1916E-01	3.6627E-04	-4.3150E-04	-4.0083E-04	-2.4325E-03	-5.4159E-02	-1.0945E-02
4.550	-2.2474E-03	1.1111E-04	9.6007E-02	-6.5990E-02	3.1162E-04	-3.8065E-04	-9.2514E-04	1.9842E-04	-5.1939E-02	-1.8208E-02
4.600	-2.1838E-03	1.2472E-03	8.9626E-02	-1.5233E-02	2.4929E-04	-3.1081E-04	-1.2781E-03	2.6254E-03	-4.6949E-02	-2.3937E-02
4.650	-2.0175E-03	2.0173E-03	7.8211E-02	3.0836E-02	1.8306E-04	-2.3072E-04	-1.4665E-03	4.7304E-03	-3.9690E-02	-2.7959E-02
4.700	-1.7701E-03	2.4405E-03	6.2883E-02	7.0386E-02	1.1651E-04	-1.4835E-04	-1.5056E-03	6.4222E-03	-3.0747E-02	-3.0202E-02
4.750	-1.4645E-03	2.5541E-03	4.4890E-02	1.0208E-01	5.2855E-05	-7.0574E-05	-1.4177E-03	7.6392E-03	-2.0753E-02	-3.0694E-02
4.800	-1.1239E-03	2.4089E-03	2.5529E-02	1.2509E-01	-5.1233E-06	-2.8803E-06	-1.2292E-03	8.3506E-03	-1.0352E-02	-2.9551E-02
4.850	-7.7058E-04	2.0641E-03	6.0589E-03	1.3912E-01	-5.5230E-05	5.0772E-05	-9.6931E-04	8.5561E-03	-1.5592E-04	-2.6965E-02
4.900	-4.2465E-04	1.5827E-03	-1.2359E-02	1.4435E-01	-9.5877E-05	8.7989E-05	-6.6757E-04	8.2827E-03	9.2812E-03	-2.3191E-02
4.950	-1.0364E-04	1.0271E-03	-2.8724E-02	1.4138E-01	-1.2611E-04	1.0789E-04	-3.5212E-04	7.5819E-03	1.7492E-02	-1.8524E-02
5.000	1.7833E-04	4.5558E-04	-4.2237E-02	1.3118E-01	-1.4560E-04	1.1096E-04	-4.8277E-05	6.5246E-03	2.4116E-02	-1.3283E-02
5.050	4.1079E-04	-8.1127E-05	-5.2332E-02	1.1502E-01	-1.5459E-04	9.8882E-05	2.2269E-04	5.1956E-03	2.8907E-02	-7.7902E-03

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	V1-DOT	V2-DOT	V3-DOT	V4-DOT	R1-DOT	TAU1-DOT	R2-DOT	TAU2-DOT	R3-DOT	TAU3-DOT
UNITS	M/SS	M/SS	M/SS	M/SS	R/SS	R/S	R/SS	R/S	R/SS	R/S
TIME (SEC)										
5.100	5.8714E-04	-5.4171E-04	-5.8682E-02	9.4336E-02	-1.5385E-04	7.4224E-05	4.4436E-04	3.6880E-03	3.1741E-02	-2.3574E-03
5.150	7.0452E-04	-8.9583E-04	-6.1206E-02	7.0671E-02	-1.4454E-04	4.0215E-05	6.0554E-04	2.0976E-03	3.2614E-02	2.7335E-03
5.200	7.6360E-04	-1.1247E-03	-6.0047E-02	4.5581E-02	-1.2817E-04	4.4013E-07	7.0044E-04	5.1704E-04	3.1629E-02	7.2415E-03
5.250	7.6815E-04	-1.2209E-03	-5.5546E-02	2.0549E-02	-1.0645E-04	-4.1438E-05	7.2834E-04	-9.6866E-04	2.8983E-02	1.0976E-02
5.300	7.2448E-04	-1.1876E-03	-4.8209E-02	-3.0834E-03	-8.1190E-05	-8.1925E-05	6.9311E-04	-2.2863E-03	2.4951E-02	1.3804E-02
5.350	6.4091E-04	-1.0368E-03	-3.8664E-02	-2.4176E-02	-5.4189E-05	-1.1791E-04	6.0253E-04	-3.3778E-03	1.9863E-02	1.5650E-02
5.400	5.2703E-04	-7.8833E-04	-2.7612E-02	-4.1830E-02	-2.7162E-05	-1.4685E-04	4.6729E-04	-4.2015E-03	1.4078E-02	1.6498E-02
5.450	3.9309E-04	-4.6687E-04	-1.5788E-02	-5.5414E-02	-1.6371E-06	-1.6685E-04	3.0016E-04	-4.7340E-03	7.9695E-03	1.6388E-02
5.500	2.4935E-04	-1.0044E-04	-3.9118E-03	-6.4574E-02	2.1097E-05	-1.7678E-04	1.1487E-04	-4.9693E-03	1.8959E-03	1.5405E-02
5.550	1.0554E-04	2.8196E-04	7.3483E-03	-6.9227E-02	4.0042E-05	-1.7622E-04	-7.4753E-05	-4.9183E-03	-3.8130E-03	1.3677E-02
5.600	-2.9661E-05	6.5235E-04	1.7411E-02	-6.9542E-02	5.4510E-05	-1.6552E-04	-2.5571E-04	-4.6062E-03	-8.8739E-03	1.1358E-02
5.650	-1.4896E-04	9.8547E-04	2.5806E-02	-6.5907E-02	6.4134E-05	-1.4562E-04	-4.1653E-04	-4.0707E-03	-1.3061E-02	8.6230E-03
5.700	-2.4675E-04	1.2602E-03	3.2191E-02	-5.8890E-02	6.8856E-05	-1.1802E-04	-5.4787E-04	-3.3585E-03	-1.6215E-02	5.6549E-03
5.750	-3.1924E-04	1.4604E-03	3.6364E-02	-4.9190E-02	6.8898E-05	-8.4630E-05	-6.4290E-04	-2.5222E-03	-1.8244E-02	2.6330E-03
5.800	-3.6450E-04	1.5759E-03	3.8258E-02	-3.7590E-02	6.4725E-05	-4.7590E-05	-6.9753E-04	-1.6169E-03	-1.9126E-02	-2.7475E-04
5.850	-3.8235E-04	1.6024E-03	3.7939E-02	-2.4907E-02	5.6994E-05	-9.1616E-06	-7.1043E-04	-6.9705E-04	-1.8904E-02	-2.9210E-03
5.900	-3.7428E-04	1.5415E-03	3.5591E-02	-1.1945E-02	4.6503E-05	2.8431E-05	-6.8289E-04	1.8641E-04	-1.7677E-02	-5.1844E-03
5.950	-3.4311E-04	1.3998E-03	3.1492E-02	5.5003E-04	3.4128E-05	6.3133E-05	-6.1857E-04	9.8865E-04	-1.5590E-02	-6.9745E-03
6.000	-2.9278E-04	1.1888E-03	2.5999E-02	1.1923E-02	2.0771E-05	9.3165E-05	-5.2309E-04	1.6728E-03	-1.2825E-02	-8.2339E-03

JUL 31, 1984
SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	R4-DOT	DY	V1	YAW1	TAU1	YAW2	TAU2	YAW3	TAU3	YAW4
UNITS	R/SS	R/S	M/S	R/S	RAD	R/S	RAD	R/S	RAD	R/S
TIME (SEC)										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.050	-7.3907E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.100	-2.1534E-04	0.0	1.6168E-03	2.2324E-03	5.4378E-05	1.6487E-04	7.4032E-06	-1.3860E-04	-3.3121E-06	-4.8783E-06
0.150	-5.3604E-04	0.0	2.3940E-03	6.1444E-03	2.5097E-04	5.5112E-04	3.9028E-05	-4.3415E-04	-1.6901E-05	-2.0881E-05
0.200	-1.1285E-03	0.0	7.4571E-04	1.1292E-02	6.4905E-04	1.2464E-03	1.1637E-04	-9.0338E-04	-4.8269E-05	-5.9378E-05
0.250	-2.0542E-03	0.0	-4.2659E-03	1.7323E-02	1.2833E-03	2.3495E-03	2.6599E-04	-1.5389E-03	-1.0456E-04	-1.3567E-04
0.300	-3.3205E-03	0.0	-1.3109E-02	2.3966E-02	2.1681E-03	3.9559E-03	5.1801E-04	-2.2933E-03	-1.9078E-04	-2.6687E-04
0.350	-4.7815E-03	0.0	-2.5919E-02	3.1011E-02	3.3012E-03	6.1474E-03	9.0350E-04	-3.0721E-03	-3.0755E-04	-4.6860E-04
0.400	-6.2712E-03	0.0	-4.4228E-02	3.6071E-02	4.6133E-03	8.8215E-03	1.4438E-03	-3.5955E-03	-4.4564E-04	-7.4555E-04
0.450	-7.3945E-03	0.0	-6.5350E-02	3.9586E-02	5.9927E-03	1.1961E-02	2.1454E-03	-3.6651E-03	-5.8386E-04	-1.0897E-03
0.500	-7.6688E-03	0.0	-8.7388E-02	4.1918E-02	7.3496E-03	1.5493E-02	3.0017E-03	-3.0585E-03	-6.9127E-04	-1.4709E-03
0.550	-6.5549E-03	0.0	-1.0905E-01	4.3364E-02	8.6157E-03	1.9312E-02	3.9906E-03	-1.5688E-03	-7.2817E-04	-1.8334E-03
0.600	-3.5135E-03	0.0	-1.2952E-01	4.4161E-02	9.7413E-03	2.3294E-02	5.0751E-03	9.6152E-04	-6.4911E-04	-2.0942E-03
0.650	1.9237E-03	0.0	-1.4831E-01	4.4496E-02	1.0694E-02	2.7311E-02	6.2056E-03	4.6154E-03	-4.0732E-04	-2.1447E-03
0.700	1.0082E-02	0.0	-1.6518E-01	4.4514E-02	1.1456E-02	3.1239E-02	7.3245E-03	9.3864E-03	3.9938E-05	-1.8564E-03
0.750	2.1153E-02	0.0	-1.8006E-01	4.4325E-02	1.2022E-02	3.4970E-02	8.3706E-03	1.5175E-02	7.2599E-04	-1.0891E-03
0.800	3.4995E-02	0.0	-1.9462E-01	4.1778E-02	1.2340E-02	3.8243E-02	9.2778E-03	2.1931E-02	1.6732E-03	3.0161E-04
0.850	5.1313E-02	0.0	-2.0653E-01	3.7486E-02	1.2336E-02	4.0927E-02	9.9774E-03	2.9414E-02	2.8896E-03	2.4482E-03
0.900	6.9524E-02	0.0	-2.1436E-01	3.1934E-02	1.1967E-02	4.2881E-02	1.0407E-02	3.7325E-02	4.3636E-03	5.4610E-03
0.950	8.8781E-02	0.0	-2.1736E-01	2.5501E-02	1.1221E-02	4.3970E-02	1.0515E-02	4.5316E-02	6.0628E-03	9.4145E-03
1.000	1.0801E-01	0.0	-2.1525E-01	1.8479E-02	1.0107E-02	4.4085E-02	1.0259E-02	5.2993E-02	7.9335E-03	1.4335E-02
1.050	1.2596E-01	0.0	-2.0806E-01	1.1087E-02	8.6520E-03	4.3145E-02	9.6161E-03	5.9940E-02	9.9019E-03	2.0190E-02
1.100	1.4126E-01	0.0	-1.9605E-01	3.4838E-03	6.8960E-03	4.1105E-02	8.5782E-03	6.5737E-02	1.1876E-02	2.6883E-02
1.150	1.5254E-01	0.0	-1.7959E-01	-4.2147E-03	4.8868E-03	3.7956E-02	7.1578E-03	6.9987E-02	1.3751E-02	3.4246E-02
1.200	1.5845E-01	0.0	-1.5912E-01	-1.1929E-02	2.6768E-03	3.3724E-02	5.3862E-03	7.2343E-02	1.5413E-02	4.2044E-02
1.250	1.5784E-01	0.0	-1.3510E-01	-1.9608E-02	3.1934E-04	2.8463E-02	3.3125E-03	7.2531E-02	1.6744E-02	4.9979E-02
1.300	1.4980E-01	0.0	-1.0797E-01	-2.7219E-02	-2.1333E-03	2.2255E-02	1.0005E-03	7.0368E-02	1.7633E-02	5.7700E-02
1.350	1.3366E-01	0.0	-7.8175E-02	-3.4745E-02	-4.6325E-03	1.5203E-02	-1.4747E-03	6.5775E-02	1.7981E-02	6.4821E-02
1.400	1.0924E-01	0.0	-4.4470E-02	-3.9946E-02	-7.0800E-03	7.5897E-03	-4.0237E-03	5.8645E-02	1.7703E-02	7.0928E-02
1.450	7.6699E-02	0.0	-9.6595E-03	-4.3377E-02	-9.3503E-03	-4.0253E-04	-6.5462E-03	4.9101E-02	1.6736E-02	7.5609E-02
1.500	3.6630E-02	0.0	2.4369E-02	-4.5484E-02	-1.1353E-02	-8.5545E-03	-8.9402E-03	3.7367E-02	1.5046E-02	7.8472E-02
1.550	-9.8922E-03	0.0	5.6416E-02	-4.6629E-02	-1.3028E-02	-1.6637E-02	-1.1106E-02	2.3780E-02	1.2631E-02	7.9165E-02
1.600	-6.1357E-02	0.0	8.5794E-02	-4.7090E-02	-1.4345E-02	-2.4429E-02	-1.2953E-02	8.7768E-03	9.5251E-03	7.7400E-02
1.650	-1.1586E-01	0.0	1.1218E-01	-4.7086E-02	-1.5295E-02	-3.1732E-02	-1.4404E-02	-7.1100E-03	5.7984E-03	7.2978E-02
1.700	-1.7118E-01	0.0	1.3550E-01	-4.6781E-02	-1.5887E-02	-3.8378E-02	-1.5400E-02	-2.3286E-02	1.5574E-03	6.5800E-02
1.750	-2.2494E-01	0.0	1.5584E-01	-4.6297E-02	-1.6145E-02	-4.4238E-02	-1.5906E-02	-3.9123E-02	-3.0589E-03	5.5887E-02
1.800	-2.7460E-01	0.0	1.7503E-01	-4.3487E-02	-1.6052E-02	-4.9053E-02	-1.5905E-02	-5.4140E-02	-7.8876E-03	4.3378E-02
1.850	-3.1777E-01	0.0	1.9087E-01	-3.8966E-02	-1.5560E-02	-5.2715E-02	-1.5398E-02	-6.7774E-02	-1.2750E-02	2.8539E-02
1.900	-3.5223E-01	0.0	2.0204E-01	-3.3219E-02	-1.4657E-02	-5.5120E-02	-1.4407E-02	-7.9539E-02	-1.7456E-02	1.1750E-02
1.950	-3.7607E-01	0.0	2.0789E-01	-2.6622E-02	-1.3358E-02	-5.6186E-02	-1.2970E-02	-8.9032E-02	-2.1817E-02	-6.5038E-03
2.000	-3.8775E-01	0.0	2.0821E-01	-1.9462E-02	-1.1695E-02	-5.5865E-02	-1.1140E-02	-9.5937E-02	-2.5652E-02	-2.5651E-02
2.050	-3.8619E-01	0.0	2.0311E-01	-1.1954E-02	-9.7153E-03	-5.4146E-02	-8.9837E-03	-1.0003E-01	-2.8796E-02	-4.5055E-02
2.100	-3.7091E-01	0.0	1.9127E-01	-6.4847E-03	-7.5297E-03	-5.1220E-02	-6.5824E-03	-1.0106E-01	-3.1106E-02	-6.4040E-02
2.150	-3.4188E-01	0.0	1.7556E-01	-2.6137E-03	-5.2865E-03	-4.7209E-02	-4.0335E-03	-9.8977E-02	-3.2464E-02	-8.1917E-02
2.200	-2.9966E-01	0.0	1.5802E-01	2.7960E-05	-3.1057E-03	-4.2296E-02	-1.4414E-03	-9.3847E-02	-3.2791E-02	-9.8006E-02
2.250	-2.4540E-01	0.0	1.4010E-01	1.7424E-03	-1.0808E-03	-3.6702E-02	1.0852E-03	-8.5851E-02	-3.2041E-02	-1.1168E-01
2.300	-1.8078E-01	0.0	1.2270E-01	2.7731E-03	7.1999E-04	-3.0666E-02	3.4382E-03	-7.5299E-02	-3.0215E-02	-1.2238E-01
2.350	-1.0800E-01	0.0	1.0643E-01	3.3128E-03	2.2515E-03	-2.4424E-02	5.5165E-03	-6.2624E-02	-2.7355E-02	-1.2962E-01
2.400	-2.9679E-02	0.0	9.1570E-02	3.5115E-03	3.4883E-03	-1.8201E-02	7.2315E-03	-4.8365E-02	-2.3551E-02	-1.3308E-01
2.450	5.1205E-02	0.0	7.8265E-02	3.4837E-03	4.4226E-03	-1.2197E-02	8.5131E-03	-3.3142E-02	-1.8934E-02	-1.3255E-01
2.500	1.3147E-01	0.0	6.6512E-02	3.3149E-03	5.0607E-03	-6.5857E-03	9.3144E-03	-1.7622E-02	-1.3673E-02	-1.2797E-01

**********TIME HISTORY OF BASELINE DOUBLE FROM LINEAR MODEL**********

JUL 31, 1984 PAGE 12

SOLUTION CONDITION 1 VELOCITY 23.148 M/S

DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	R4-DOT	DY	V1	YAW1	TAU1	YAW2	TAU2	YAW3	TAU3	YAW4
UNITS	R/SS	R/S	M/S	R/S	RAD	R/S	RAD	R/S	RAD	R/S
TIME (SEC)										
2.550	2.0783E-01	0.0	5.6234E-02	3.0672E-03	5.4203E-03	-1.5046E-03	9.6143E-03	-2.4839E-03	-7.9709E-03	-1.1947E-01
2.600	2.7712E-01	0.0	4.7306E-02	2.7841E-03	5.5279E-03	2.9419E-03	9.4189E-03	1.1627E-02	-2.0530E-03	-1.0731E-01
2.650	3.3636E-01	0.0	3.9583E-02	2.4953E-03	5.4161E-03	6.6845E-03	8.7609E-03	2.4129E-02	3.8419E-03	-9.1923E-02
2.700	3.8301E-01	0.0	3.2914E-02	2.2192E-03	5.1215E-03	9.6868E-03	7.6970E-03	3.4540E-02	9.4730E-03	-7.3881E-02
2.750	4.1502E-01	0.0	2.7155E-02	1.9664E-03	4.6822E-03	1.1943E-02	6.3040E-03	4.2500E-02	1.4610E-02	-5.3866E-02
2.800	4.3101E-01	0.0	2.2174E-02	1.7419E-03	4.1364E-03	1.3474E-02	4.6737E-03	4.7789E-02	1.9045E-02	-3.2647E-02
2.850	4.3032E-01	0.0	1.7856E-02	1.5464E-03	3.5209E-03	1.4323E-02	2.9069E-03	5.0335E-02	2.2602E-02	-1.1044E-02
2.900	4.1309E-01	0.0	1.4104E-02	1.3783E-03	2.8695E-03	1.4554E-02	1.1069E-03	5.0207E-02	2.5146E-02	1.0109E-02
2.950	3.8019E-01	0.0	1.0838E-02	1.2343E-03	2.2128E-03	1.4243E-02	-6.2631E-04	4.7613E-02	2.6591E-02	3.0004E-02
3.000	3.3326E-01	0.0	7.9947E-03	1.1103E-03	1.5766E-03	1.3475E-02	-2.2019E-03	4.2872E-02	2.6904E-02	4.7894E-02
3.050	2.7456E-01	0.0	5.5232E-03	1.0021E-03	9.8261E-04	1.2343E-02	-3.5431E-03	3.6396E-02	2.6104E-02	6.3133E-02
3.100	2.0689E-01	0.0	3.3856E-03	9.0572E-04	4.4728E-04	1.0938E-02	-4.5907E-03	2.8661E-02	2.4262E-02	7.5200E-02
3.150	1.3341E-01	0.0	1.5525E-03	8.1768E-04	-1.7505E-05	9.3523E-03	-5.3058E-03	2.0174E-02	2.1497E-02	8.3725E-02
3.200	5.7533E-02	0.0	1.2299E-06	7.3506E-04	-4.0448E-04	7.6695E-03	-5.6705E-03	1.1448E-02	1.7966E-02	8.8501E-02
3.250	-1.7339E-02	0.0	-1.2862E-03	6.5567E-04	-7.1058E-04	5.9673E-03	-5.6880E-03	2.9654E-03	1.3859E-02	8.9495E-02
3.300	-8.7914E-02	0.0	-2.3252E-03	5.7801E-04	-9.3643E-04	4.3134E-03	-5.3809E-03	-4.8378E-03	9.3854E-03	8.6839E-02
3.350	-1.5122E-01	0.0	-3.1302E-03	5.0125E-04	-1.0858E-03	2.7640E-03	-4.7886E-03	-1.1599E-02	4.7646E-03	8.0825E-02
3.400	-2.0471E-01	0.0	-3.7160E-03	4.2517E-04	-1.1652E-03	1.3639E-03	-3.9641E-03	-1.7041E-02	2.1382E-04	7.1881E-02
3.450	-2.4642E-01	0.0	-4.0981E-03	3.5002E-04	-1.1827E-03	1.4553E-04	-2.9701E-03	-2.0982E-02	-4.0628E-03	6.0551E-02
3.500	-2.7501E-01	0.0	-4.2938E-03	2.7646E-04	-1.1481E-03	-8.7052E-04	-1.8745E-03	-2.3336E-02	-7.8836E-03	4.7458E-02
3.550	-2.8983E-01	0.0	-4.3222E-03	2.0542E-04	-1.0715E-03	-1.6746E-03	-7.4632E-04	-2.4115E-02	-1.1098E-02	3.3280E-02
3.600	-2.9092E-01	0.0	-4.2043E-03	1.3797E-04	-9.6356E-04	-2.2674E-03	3.4838E-04	-2.3415E-02	-1.3592E-02	1.8705E-02
3.650	-2.7898E-01	0.0	-3.9625E-03	7.5266E-05	-8.3430E-04	-2.6580E-03	1.3500E-03	-2.1407E-02	-1.5293E-02	4.4057E-03
3.700	-2.5530E-01	0.0	-3.6203E-03	1.8400E-05	-6.9324E-04	-2.8627E-03	2.2084E-03	-1.8322E-02	-1.6170E-02	-8.9968E-03
3.750	-2.2168E-01	0.0	-3.2018E-03	-3.1657E-05	-5.4881E-04	-2.9036E-03	2.8852E-03	-1.4430E-02	-1.6236E-02	-2.0959E-02
3.800	-1.8030E-01	0.0	-2.7308E-03	-7.4124E-05	-4.0822E-04	-2.8064E-03	3.3548E-03	-1.0025E-02	-1.5540E-02	-3.1035E-02
3.850	-1.3359E-01	0.0	-2.2305E-03	-1.0847E-04	-2.7728E-04	-2.5989E-03	3.6053E-03	-5.4038E-03	-1.4168E-02	-3.8900E-02
3.900	-8.4109E-02	0.0	-1.7225E-03	-1.3441E-04	-1.6040E-04	-2.3097E-03	3.6378E-03	-8.5212E-04	-1.2232E-02	-4.4348E-02
3.950	-3.4387E-02	0.0	-1.2263E-03	-1.5199E-04	-6.0510E-05	-1.9667E-03	3.4659E-03	3.3738E-03	-9.8654E-03	-4.7307E-02
4.000	1.3180E-02	0.0	-7.5898E-04	-1.6148E-04	2.0753E-05	-1.5959E-03	3.1133E-03	7.0572E-03	-7.2138E-03	-4.7823E-02
4.050	5.6459E-02	0.0	-3.3460E-04	-1.6344E-04	8.2984E-05	-1.2204E-03	2.6125E-03	1.0030E-02	-4.4273E-03	-4.6060E-02
4.100	9.3666E-02	0.0	3.5994E-05	-1.5866E-04	1.2682E-04	-8.5987E-04	2.0017E-03	1.2180E-02	-1.6522E-03	-4.2279E-02
4.150	1.2344E-01	0.0	3.4529E-04	-1.4810E-04	1.5372E-04	-5.2997E-04	1.3227E-03	1.3450E-02	9.7589E-04	-3.6818E-02
4.200	1.4487E-01	0.0	5.8907E-04	-1.3286E-04	1.6579E-04	-2.4230E-04	6.1777E-04	1.3837E-02	3.3384E-03	-3.0074E-02
4.250	1.5753E-01	0.0	7.6627E-04	-1.1411E-04	1.6555E-04	-4.3589E-06	-7.2155E-05	1.3389E-02	5.3389E-03	-2.2478E-02
4.300	1.6147E-01	0.0	8.7873E-04	-9.3055E-05	1.5574E-04	1.8025E-04	-7.1010E-04	1.2200E-02	6.9058E-03	-1.4467E-02
4.350	1.5717E-01	0.0	9.3078E-04	-7.0875E-05	1.3913E-04	3.1138E-04	-1.2647E-03	1.0394E-02	7.9954E-03	-6.4680E-03
4.400	1.4547E-01	0.0	9.2884E-04	-4.8669E-05	1.1836E-04	3.9188E-04	-1.7114E-03	8.1237E-03	8.5911E-03	1.1265E-03
4.450	1.2755E-01	0.0	8.8088E-04	-2.7423E-05	9.5818E-05	4.2694E-04	-2.0336E-03	5.5546E-03	8.7026E-03	7.9752E-03
4.500	1.0479E-01	0.0	7.9596E-04	-7.9740E-06	7.3536E-05	4.2352E-04	-2.2227E-03	2.8561E-03	8.3639E-03	1.3801E-02
4.550	7.8738E-02	0.0	6.8363E-04	9.0131E-06	5.3135E-05	3.8966E-04	-2.2780E-03	1.9124E-04	7.6292E-03	1.8399E-02
4.600	5.0967E-02	0.0	5.5352E-04	2.3060E-05	3.5788E-05	3.3387E-04	-2.2063E-03	-2.2916E-03	6.5688E-03	2.1646E-02
4.650	2.3026E-02	0.0	4.1483E-04	3.3878E-05	2.2224E-05	2.6459E-04	-2.0208E-03	-4.4658E-03	5.2640E-03	2.3493E-02
4.700	-3.6473E-03	0.0	2.7599E-04	4.1361E-05	1.2753E-05	1.8971E-04	-1.7401E-03	-6.2325E-03	3.8025E-03	2.3970E-02
4.750	-2.7796E-02	0.0	1.4431E-04	4.5577E-05	7.3117E-06	1.1615E-04	-1.3865E-03	-7.5230E-03	2.2730E-03	2.3171E-02
4.800	-4.8393E-02	0.0	2.5799E-05	4.6742E-05	5.5269E-06	4.9622E-05	-9.8466E-04	-8.3010E-03	7.6046E-04	2.1249E-02
4.850	-6.4675E-02	0.0	-7.5020E-05	4.5196E-05	6.7889E-06	-5.5759E-06	-5.5992E-04	-8.5616E-03	-6.5796E-04	1.8404E-02
4.900	-7.6167E-02	0.0	-1.5513E-04	4.1377E-05	1.0329E-05	-4.6612E-05	-1.3704E-04	-8.3293E-03	-1.9162E-03	1.4862E-02
4.950	-8.2677E-02	0.0	-2.1300E-04	3.5782E-05	1.5298E-05	-7.2106E-05	2.6122E-04	-7.6540E-03	-2.9622E-03	1.0870E-02
5.000	-8.4291E-02	0.0	-2.4849E-04	2.8945E-05	2.0837E-05	-8.2020E-05	6.1520E-04	-6.6066E-03	-3.7591E-03	6.6759E-03
5.050	-8.1342E-02	0.0	-2.6272E-04	2.1398E-05	2.6142E-05	-7.7484E-05	9.0914E-04	-5.2730E-03	-4.2863E-03	2.5171E-03

**********TIME HISTORY OF BASELINE DOUBLE FROM LINEAR MODEL**********

JUL 31, 1984

SOLUTION CONDITION 1 VELOCITY 23.148 M/S

DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	R4-DOT	DY	V1	YAW1	TAU1	YAW2	TAU2	YAW3	TAU3	YAW4
UNITS	R/SS	R/S	M/S	R/S	RAD	R/S	RAD	R/S	RAD	R/S
TIME (SEC)										
5.100	-7.4375E-02	0.0	-2.5781E-04	1.3648E-05	3.0515E-05	-6.0575E-05	1.1318E-03	-3.7486E-03	-4.5391E-03	-1.3912E-03
5.150	-6.4099E-02	0.0	-2.3668E-04	6.1556E-06	3.3408E-05	-3.4060E-05	1.2766E-03	-2.1316E-03	-4.5277E-03	-4.8651E-03
5.200	-5.1340E-02	0.0	-2.0283E-04	-6.8835E-07	3.4441E-05	-1.1285E-06	1.3417E-03	-5.1817E-04	-4.2755E-03	-7.7597E-03
5.250	-3.6986E-02	0.0	-1.6001E-04	-6.5726E-06	3.3417E-05	3.4865E-05	1.3299E-03	1.0035E-03	-3.8165E-03	-9.9726E-03
5.300	-2.1933E-02	0.0	-1.1206E-04	-1.1275E-05	3.0320E-05	7.0651E-05	1.2476E-03	2.3570E-03	-3.1930E-03	-1.1447E-02
5.350	-7.0416E-03	0.0	-6.2637E-05	-1.4663E-05	2.5300E-05	1.0325E-04	1.1050E-03	3.4810E-03	-2.4525E-03	-1.2169E-02
5.400	6.9107E-03	0.0	-1.5057E-05	-1.6693E-05	1.8647E-05	1.3016E-04	9.1434E-04	4.3317E-03	-1.6447E-03	-1.2167E-02
5.450	1.9260E-02	0.0	2.7863E-05	-1.7404E-05	1.0764E-05	1.4945E-04	6.8971E-04	4.8834E-03	-8.1872E-04	-1.1504E-02
5.500	2.9485E-02	0.0	6.3908E-05	-1.6904E-05	2.1298E-06	1.5987E-04	4.4590E-04	5.1292E-03	-2.0492E-05	-1.0276E-02
5.550	3.7219E-02	0.0	9.1522E-05	-1.5358E-05	-6.7385E-06	1.6086E-04	1.9756E-04	5.0791E-03	7.0935E-04	-8.5975E-03
5.600	4.2264E-02	0.0	1.0983E-04	-1.2974E-05	-1.5323E-05	1.5254E-04	-4.1566E-05	4.7587E-03	1.3373E-03	-6.5990E-03
5.650	4.4577E-02	0.0	1.1862E-04	-9.9876E-06	-2.3137E-05	1.3563E-04	-2.5933E-04	4.2063E-03	1.8382E-03	-4.4167E-03
5.700	4.4270E-02	0.0	1.1828E-04	-6.6427E-06	-2.9756E-05	1.1138E-04	-4.4569E-04	3.4699E-03	2.1957E-03	-2.1850E-03
5.750	4.1583E-02	0.0	1.0970E-04	-3.1801E-06	-3.4842E-05	8.1450E-05	-5.9311E-04	2.6036E-03	2.4028E-03	-2.9409E-05
5.800	3.6866E-02	0.0	9.4210E-05	1.7669E-07	-3.8158E-05	4.7767E-05	-6.9676E-04	1.6647E-03	2.4610E-03	1.9394E-03
5.850	3.0547E-02	0.0	7.3416E-05	3.2329E-06	-3.9578E-05	1.2395E-05	-7.5456E-04	7.0945E-04	2.3797E-03	3.6304E-03
5.900	2.3105E-02	0.0	4.9101E-05	5.8301E-06	-3.9088E-05	-2.2601E-05	-7.6707E-04	-2.0901E-04	2.1752E-03	4.9754E-03
5.950	1.5039E-02	0.0	2.3101E-05	7.8518E-06	-3.6783E-05	-5.5281E-05	-7.3728E-04	-1.0439E-03	1.8692E-03	5.9305E-03
6.000	6.8414E-03	0.0	-2.8152E-06	9.2265E-06	-3.2853E-05	-8.3938E-05	-6.7018E-04	-1.7567E-03	1.4867E-03	6.4771E-03

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9
---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	Y
UNITS	RAD
TIME (SEC)	
0.0	0.0
0.050	1.6665E-03
0.100	3.3330E-03
0.150	4.9995E-03
0.200	6.6660E-03
0.250	8.3325E-03
0.300	9.9990E-03
0.350	9.9990E-03
0.400	9.9990E-03
0.450	9.9990E-03
0.500	9.9990E-03
0.550	9.9990E-03
0.600	9.9990E-03
0.650	9.9990E-03
0.700	9.9990E-03
0.750	8.3325E-03
0.800	6.6660E-03
0.850	4.9995E-03
0.900	3.3330E-03
0.950	1.6665E-03
1.000	-1.9866E-09
1.050	-1.6665E-03
1.100	-3.3330E-03
1.150	-4.9995E-03
1.200	-6.6660E-03
1.250	-8.3325E-03
1.300	-9.9990E-03
1.350	-9.9990E-03
1.400	-9.9990E-03
1.450	-9.9990E-03
1.500	-9.9990E-03
1.550	-9.9990E-03
1.600	-9.9990E-03
1.650	-9.9990E-03
1.700	-9.9990E-03
1.750	-8.3325E-03
1.800	-6.6660E-03
1.850	-4.9995E-03
1.900	-3.3330E-03
1.950	-1.6665E-03
2.000	2.9799E-08
2.050	2.9799E-08
2.100	2.9799E-08
2.150	2.9799E-08
2.200	2.9799E-08
2.250	2.9799E-08
2.300	2.9799E-08
2.350	2.9799E-08
2.400	2.9799E-08
2.450	2.9799E-08
2.500	2.9799E-08

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9
---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	Y
UNITS	RAD
TIME (SEC)	
2.550	2.9799E-08
2.600	2.9799E-08
2.650	2.9799E-08
2.700	2.9799E-08
2.750	2.9799E-08
2.800	2.9799E-08
2.850	2.9799E-08
2.900	2.9799E-08
2.950	2.9799E-08
3.000	2.9799E-08
3.050	2.9799E-08
3.100	2.9799E-08
3.150	2.9799E-08
3.200	2.9799E-08
3.250	2.9799E-08
3.300	2.9799E-08
3.350	2.9799E-08
3.400	2.9799E-08
3.450	2.9799E-08
3.500	2.9799E-08
3.550	2.9799E-08
3.600	2.9799E-08
3.650	2.9799E-08
3.700	2.9799E-08
3.750	2.9799E-08
3.800	2.9799E-08
3.850	2.9799E-08
3.900	2.9799E-08
3.950	2.9799E-08
4.000	2.9799E-08
4.050	2.9799E-08
4.100	2.9799E-08
4.150	2.9799E-08
4.200	2.9799E-08
4.250	2.9799E-08
4.300	2.9799E-08
4.350	2.9799E-08
4.400	2.9799E-08
4.450	2.9799E-08
4.500	2.9799E-08
4.550	2.9799E-08
4.600	2.9799E-08
4.650	2.9799E-08
4.700	2.9799E-08
4.750	2.9799E-08
4.800	2.9799E-08
4.850	2.9799E-08
4.900	2.9799E-08
4.950	2.9799E-08
5.000	2.9799E-08
5.050	2.9799E-08

SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9
---------- TIME HISTORIES OF OUTPUTS ----------

OUTPUT	Y
UNITS	RAD
TIME (SEC)	
5.100	2.9799E-08
5.150	2.9799E-08
5.200	2.9799E-08
5.250	2.9799E-08
5.300	2.9799E-08
5.350	2.9799E-08
5.400	2.9799E-08
5.450	2.9799E-08
5.500	2.9799E-08
5.550	2.9799E-08
5.600	2.9799E-08
5.650	2.9799E-08
5.700	2.9799E-08
5.750	2.9799E-08
5.800	2.9799E-08
5.850	2.9799E-08
5.900	2.9799E-08
5.950	2.9799E-08
6.000	2.9799E-08

**********TIME HISTORY OF BASELINE DOUBLE FROM LINEAR MODEL**********
JUL 31, 1984
SOLUTION CONDITION 1 VELOCITY 23.148 M/S
DEGREES OF FREEDOM : 1 2 3 4 5 6 7 8 9

---------- RESPONSE STATISTICS ----------

OUTPUT	UNITS	MAXIMUM VALUE	MAXIMUM TIME	MINIMUM VALUE	MINIMUM TIME
V1-DOT	M/SS	7.1296E-01	0.700	-6.4678E-01	1.700
V2-DOT	M/SS	6.7407E-01	1.000	-7.2202E-01	2.100
V3-DOT	M/SS	1.2084E+00	1.450	-1.5650E+00	2.350
V4-DOT	M/SS	1.1671E+00	1.600	-1.7076E+00	2.550
R1-DOT	R/SS	1.7391E-01	2.000	-1.8096E-01	1.150
TAU1-DOT	R/S	4.4735E-02	2.100	-4.9948E-02	1.350
R2-DOT	R/SS	1.2536E-01	2.350	-1.6310E-01	1.500
TAU2-DOT	R/S	5.1768E-02	2.150	-5.1055E-02	1.400
R3-DOT	R/SS	3.0969E-01	2.450	-3.2268E-01	1.650
TAU3-DOT	R/S	1.1893E-01	2.600	-9.7518E-02	1.800
R4-DOT	R/SS	4.3101E-01	2.800	-3.8775E-01	2.000
DY	R/S	0.0	0.0	0.0	0.0
V1	M/S	2.0821E-01	2.000	-2.1736E-01	0.950
YAW1	R/S	4.4514E-02	0.700	-4.7090E-02	1.600
TAU1	RAD	1.2340E-02	0.800	-1.6145E-02	1.750
YAW2	R/S	4.4085E-02	1.000	-5.6186E-02	1.950
TAU2	RAD	1.0515E-02	0.950	-1.5906E-02	1.750
YAW3	R/S	7.2531E-02	1.250	-1.0106E-01	2.100
TAU3	RAD	2.6904E-02	3.000	-3.2791E-02	2.200
YAW4	R/S	8.9495E-02	3.250	-1.3308E-01	2.400
Y	RAD	9.9990E-03	0.300	-9.9990E-03	1.300

---------- STATISTICS FOR MODULE TIMHIS ----------

DATA STORAGE USED BY MODULE : 0 WORDS
WORK STORAGE USED BY MODULE : 5000 WORDS
TOTAL STORAGE TO THIS POINT : 5813 WORDS

10/ CONCLUSIONS

A linear mathematical model for a general truck combination has been developed to study the yaw stability and time history response of heavy commercial vehicles. Computer programs have been written to interface this model with the MTC general purpose dynamic analysis package DYNSYS in the IBM 370 computer to provide an efficient tool for vehicle dynamic analysis. The program developed at MTC has the following advantages over similar programs:

1/ It is flexible enough to handle many special vehicle combinations, and vehicle combinations of arbitrary length. It is therefore suitable for evaluation of innovative vehicle designs that come up from time to time, or vehicles with more than three articulation points.

2/ Stability and time history response can be solved by the same computer program with only minor modification to input data.

3/ Sensitivity studies on a wide range of vehicle parameters can be performed in a single run.

Because of its relatively few input data requirements, the program may be particularly handy for preliminary stability analysis to identify vehicle combinations for further detailed analysis and/or test.

The extensive capability of a wide range of vehicle parameters for sensitivity studies will be most useful for vehicle component design.

REFERENCES

[1] MacAdam, C.C. et al, "A Computerized Model for Simulating the Braking and Steering Dynamics of Trucks, Tractor-semi-trailers, Doubles, and Triples Combinations," PHASE 4, UM-HSRI-80-58.

[2] Hazemoto, T., "Analysis of Lateral Stability for Doubles," SAE paper No. 730688, June 1973.

[3] Mallikarjunarao, C., and Fancher, P., "Analysis of the Directional Response Characteristics of Double Tankers," SAE Technical Paper Series, Paper No. 781064, December 11, 1978.

[4] Mercer, W.R.J., Billing, J.R., and Wolkowicz, M.E. "Test and Demonstration of Doubles and Triples Trailer Combinations," Ministry of Transportation and Communication, TVS-CV-82-109, August 1982.

[5] Billing, J.R., Mercer, W.R.J., Lam, C.P., Wolkowicz, M.E., and Stephenson, W.R., "Tests of B-train Converter Dolly," Ministry of Transportation and Communication, TVS-CV-82-111, May 1983.

[6] Billing, J.R., "DYNSYS: A General Purpose Computer Program Applicable to Problems of Dynamics (Users' Guide)," Ministry of Transportation and Communications, TS-79-103, August 1979.

Table 2/ Vehicle Data for a Tractor Semi-Trailer or an A-Train Double

	MASS (kg)	MOMENT OF INERTIA ($N\text{-}m^2$)	Distances are w.r.t. Front Axle/King Pin (m)					
			C.G.	1st Axle	2nd Axle	3rd Axle	1st Hitch	2nd Hitch
Tractor	6 257.13	23 075.5	1.6764	0	2.7686	4.0386	2.6289	
Semi-Trailer	32 226.46	193 007.5	2.8702	4.1656	5.2324	6.2992	0	6.7056
Dolly	2 051.70	2 444.19	1.778	1.2446	2.3114		0	1.778
2nd Trailer	27 193.56	88 387.12	2.0574	2.1082	3.1750	4.2418	0	

	Cornering Stiffness (N/r)	Aligning Torque/Slip Angle (Nm/r)	Circumferential Stiffness (N)
Tractor Axle 1	366 986.31	29 906.11	152 958.0
Axle 2	460 771.5	26 683.4	152 958.0
Axle 3	460 771.5	26 683.4	152 958.0
Semi-Trailer Axle 1	426 366.56	19 262.84	143 359.0
Axle 2	426 366.56	19 262.84	143 359.0
Axle 3	426 366.56	19 262.84	143 359.0
Dolly Axle 1	426 366.56	19 262.84	143 359.0
Axle 2	426 366.56	19 262.84	143 359.0
2nd Trailer Axle 1	426 366.56	19 262.84	143 359.0
Axle 2	426 366.56	19 262.84	143 359.0
Axle 3	426 366.56	19 262.84	143 359.0

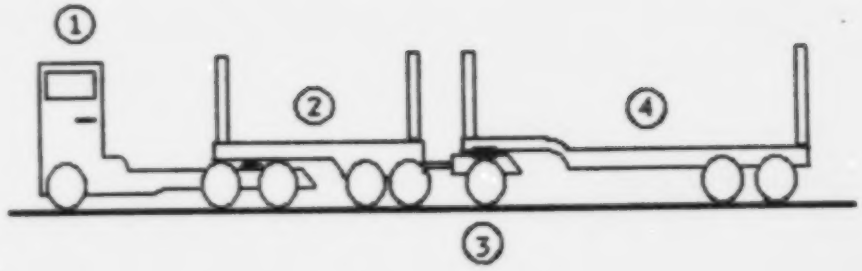

Figure 1/ A-Train Double Combination

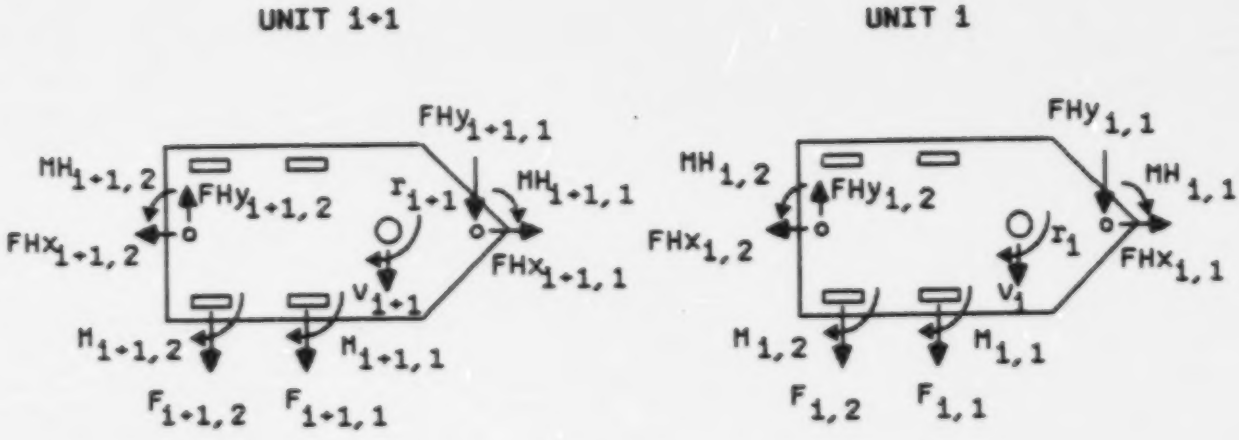

Figure 2/ Free Body Diagram of Two Consecutive Vehicle Units

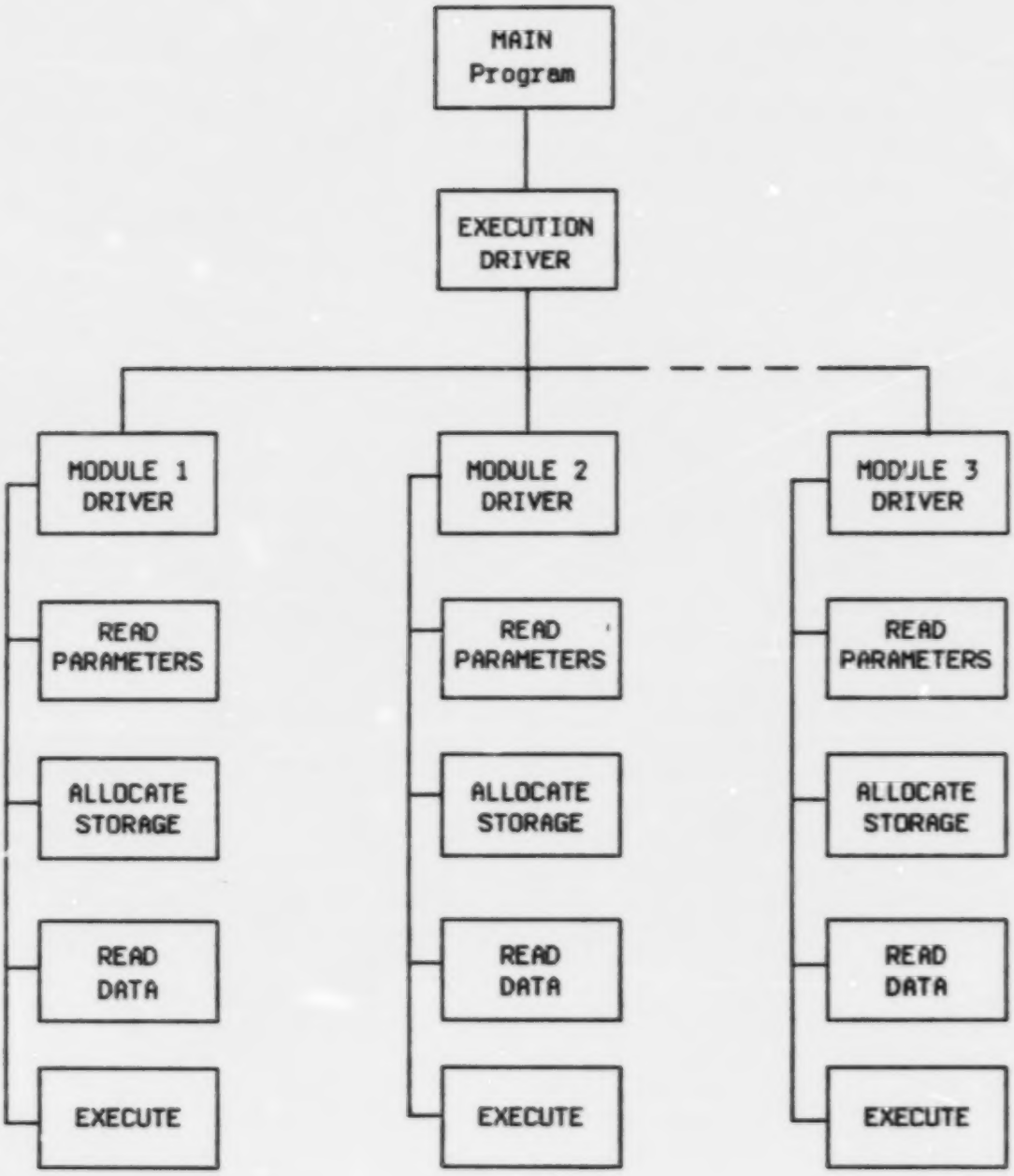

Figure 3/ Program Structure (DYNSYS)

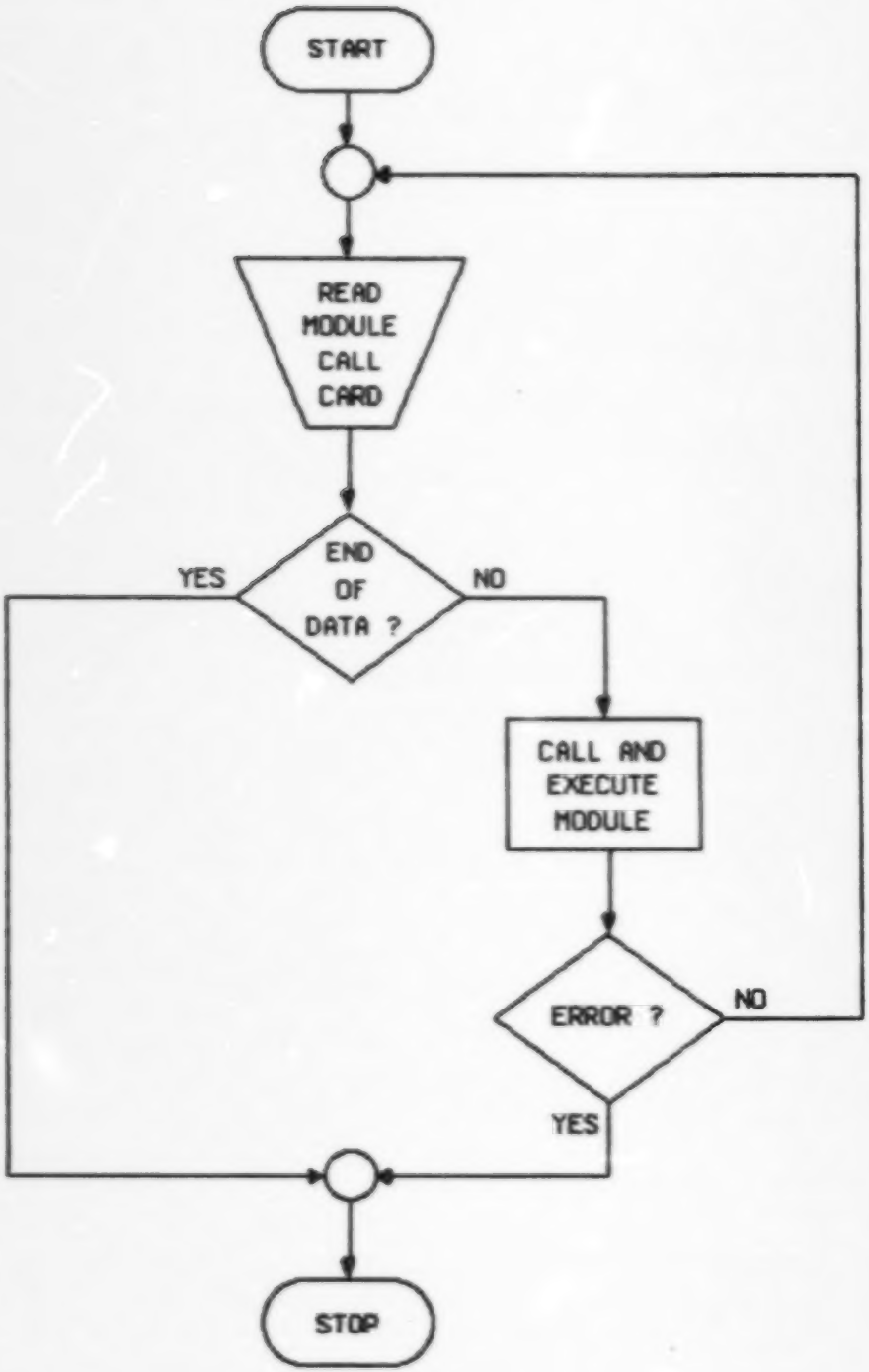

Figure 4/ Flow of Control Through Program (DYNSYS)

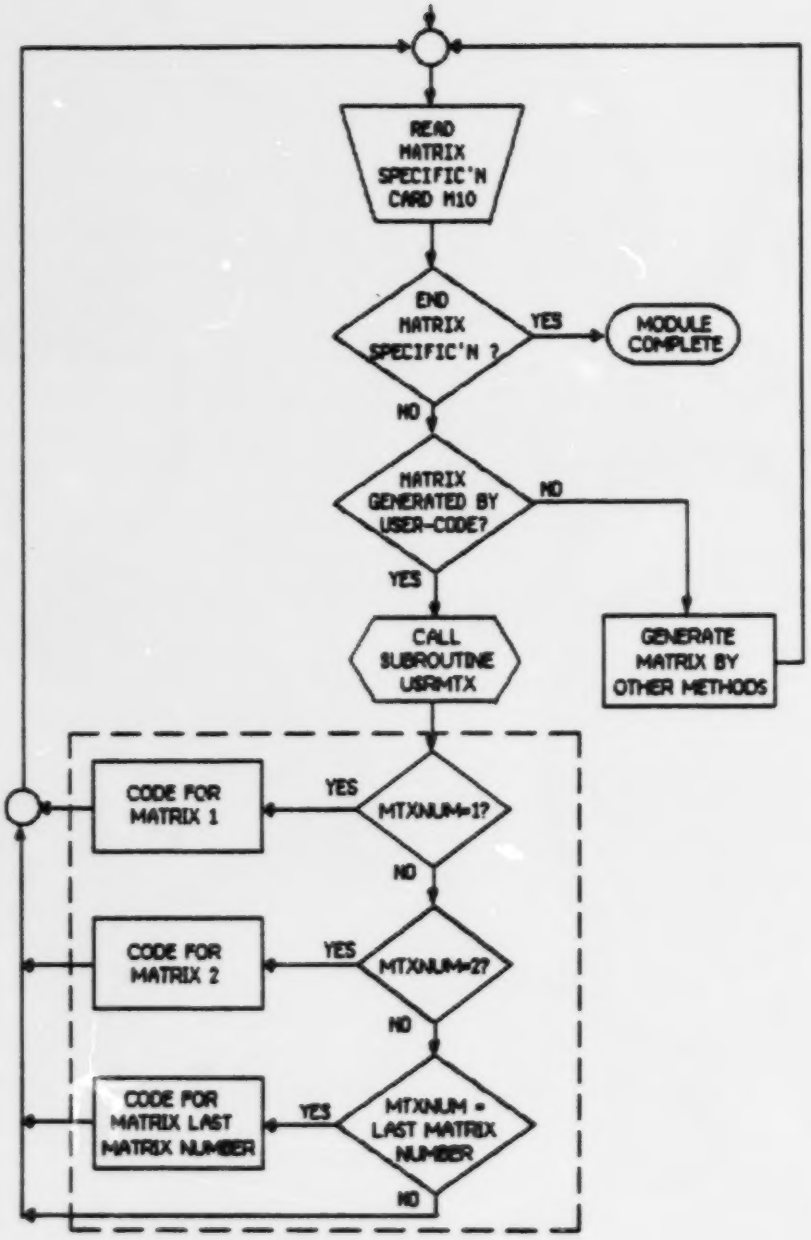

Figure 5/ Logical Flow for Generation of Matrices by User-Supplied Code (DYNSYS)

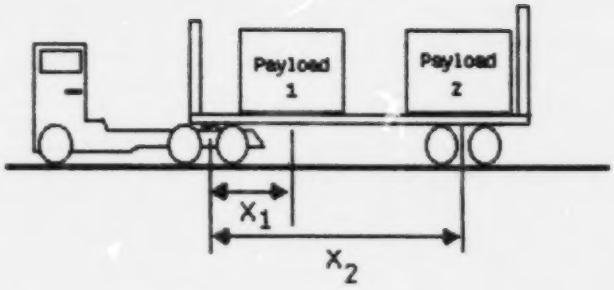

Figure 6/ Empty Vehicle and Payload

POOR

QUALITY

ORIGINAL